VOL. 29 No. 7

BULLETIN

OF THE

TORREY BOTANICAL CLUB

JULY 1902

Cytological Changes accompanying the Secretion of Diastase

BY JOHN CUTLER TORREY

(WITH PLATE 20)

From the chemical standpoint, a large amount of work has already been done on the secretion of diastase in the Gramineae. For these researches we are principally indebted to Morris and Brown. These authors have determined with great care the cells concerned in its formation, the amount secreted and its method of attack on the endosperm. Many botanists, too, have described and figured the pitting and ultimate dissolution of the starch grains in the endosperm during the progress of germination. No serious attempt, however, has been made to determine the nature and sequence of the changes occurring in the diastase-secreting cells during the elaboration of the enzyme. This paper, accordingly, embodies an attempt to throw some light on the following questions:

1. In what part of the diastase-producing cells is the ferment produced? Is it in the nucleus or in the cytoplasm?

2. How soon after the beginning of germination is diastase secreted? Is it formed intermittently or is it a continuous secretion?

Little attention has been paid to the action of the enzyme on the endosperm, except in so far as it gave evidence that diastase had been discharged from the cells.

As maize has been found to be in many ways more favorable for study than barley, it has largely furnished the material for the present paper. The latter, however, has been of value from a comparative standpoint. I take pleasure in acknowledging my

[Issued 25 July]

indebtedness to Professor Francis E. Lloyd for the suggestion of the research and kindly criticism during its progress.

Methods.—The seeds were soaked over night in water to soften the coats, and were then placed between layers of filter paper in a moist chamber. The embryos at different stages of growth were cut from the grain together with that part of the endosperm in immediate contact with the scutellum. The first series was made at time intervals. The embryos were fixed approximately every 12 hours for two days, and then at 24-hour intervals. This was found to be unsatisfactory as the rate of growth in different seeds varied greatly, and thus the chances of obtaining a sequence of stages was lessened. Accordingly, a series from the beginning of germination to five days was secured with the rate of growth as a guide, and without reference to time intervals. The length of the radicle and plumule served as an indicator. The best fixation was effected by the use of sublimate acetic 2 per cent., or of alcoholic acetic (70 per cent. alcohol 2 parts and glacial acetic acid 1 part). Flemming's fluid caused excessive blackening. Iron haematoxylin proved to be by far the most satisfactory stain, either alone or followed by Congo red as a counter stain. Auerbach's method, also, was of some value. The sections were cut for the most part 5 μ in thickness.

I. DESCRIPTION OF SEED. (PL. 20, F. 1)

Without entering upon a description of the various seed coats, a kernel of corn may be said to consist of two distinct elements—the endosperm and the embryo. The former occupies the larger part of the seed and partly clothes the adjacent embryo. The latter is on the furrowed flattened side of the kernel. It is thickest at the end attached to the cob, and gradually slopes to a point reached at about four fifths the length of the grain. Between the axis of the plantlet and the endosperm there is a thickened shield-like expansion of the hypocotyl, supposed by many to be the homologue of the cotyledon, and known as the scutellum. This is the special organ of absorption. The endosperm consists of large cells filled with starch grains imbedded in a matrix of proteid matter. Several layers of crushed and empty cells separate these well-filled cells from the scutellum. As these cells

have been emptied by the pressure of the growing scutellum during the development of the seed, we find them most numerous where the scutellum is thickest. Directly adjoining the flattened empty cells is the epidermal layer of the scutellum, the cells of which manufacture the "diastase of secretion."

These secretory cells are found at every point where the scutellum is in contact with the endosperm. At the region of the tip this secretory epithelial layer dips down at frequent intervals into the scutellum. The convolutions so produced secure a larger surface of secretion where there is greatest need for the enzyme; for the endosperm is thickest at this point and in front of the embryo. Immediately below the epithelial cells are the large loosely arranged isodiametric cells of the scutellum. The larger cells are near the central part of the scutellum. Here, too, the cell walls are thicker than at the periphery. The young shoot itself, is closely connected with the lower central portion of the scutellum. From the hypocotyledonary part there proceeds into the scutellum a branch of the vascular system which soon divides into two parts. One of these runs directly upward, and the other toward the tip of the scutellum. They both give rise to many small branchlets, but none of these find their way into the heel of the scutellum.

The diastase-secreting cells are columnar, and at the beginning of germination are about three times as long as broad (*f.* 2). The bases of the cells rest on the scutellar parenchyma, and their ends are in close apposition to the endosperm. The cell walls are extremely thin and delicate, thus permitting a free osmotic interchange. The protoplasm in early stages is finely reticulated, but becomes somewhat coarser as germination progresses. The nucleus varies greatly in its position. Although it is found as a rule near the center, it may not infrequently occur at the base or near the outer end of the cell. It is slightly elliptical with its long dimension parallel to that of the cell. The nuclear wall is very delicate. The chromatin, in the form of small granules, lies scattered in the linin network. The large, deeply staining nucleolus always lies in a vacuole. Two such nucleoli very commonly occur. Although as a rule round, a knot like projection is sometimes present. The cells in the central part of the scutellum are especially

heavily loaded with nutritive matter, which consists, for the most part, of aleurone grains and oil globules. In corn, even at the beginning of germination, starch grains are commonly found in these cells. In barley, such grains, according to Morris and Brown, are not present in the scutellum until the endosperm shows signs of depletion. Nearly all the starch grains, wherever found, are cracked because of the dehydration of the resting period.

II. ORIGIN OF DIASTASE

1. *Previous Accounts.*—It will be sufficient, for our present purpose, to point out the following pertinent facts in regard to diastase, which have been established principally through the researches of Morris and Brown.*

(*a*) There are two varieties of diatase.—One is an amylohydrolytic enzyme occurring in buds, leaves and other regions, which acts on the transitory starch grains found in the cells of these tissues. It does not act on starch paste nor pit starch granules, but dissolves them evenly.

The other is the enzyme secreted by the columnar epithelial cells in the seeds of the Gramineae. This dissolves starch paste and corrodes starch granules.

The former has been called by Morris and Brown the "diastase of translocation" and the latter the "diastase of secretion."

(*b*) This diastase of secretion begins to be formed soon after the beginning of germination and continues until the endosperm is depleted.

(*c*) The first evidence of the formation of the ferment is the appearance of granules in the columnar epithelial cells of the scutellum.

(*d*) Soon after the appearance of these granules the cells walls of the endosperm nearest the scutellum begin to be dissolved and the contained starch grains show evidence of pitting.

(*e*) Concomitant with the above-mentioned phenomena starch grains appear in the cells of the scutellum immediately below the secreting epithelial cells.

* For a detailed description of the work that has already been done on the origin of diastase and its action on the endosperm, the reader is referred to the original papers or to the chapter on Diastase in Reynold Green's Fermentation.

(*f*) If a small quantity of cane sugar is added to the starch, the latter is protected in a remarkable manner. There is no sign of pitting of the starch grains as long as any sugar remains unabsorbed by the embryo. "Thus the secretion of active diastase by the epithelium may be regarded to some extent as a starvation phenomenon."

(*g*) Lastly, in addition to the starch-dissolving enzyme (amylohydrolyst), there is present in the growing plantlet a cellulose-dissolving enzyme (cytohydrolyst). Both these enzymes are secreted by the columnar ("absorptive") epithelium.

2. *Observations.*—In previous accounts of the secretion of diastase, the statement that the epithelial cells at the beginning of germination are filled with granules seems to be the nearest approach to an accurate description of its origin. This is true as far as it goes. I have attempted to trace these diastase granules to their ultimate origin and I think that there is evidence for the conclusion that in corn and barley and probably in all the Gramineae, "diastase of secretion" arises in the nucleus of the epidermal cells of the scutellum.

My earliest preparations of corn are sections of a kernel that had been soaked in water just long enough to soften the outer coats. The protoplasm of the columnar cells is found to be much shrunken owing to the dry condition of the resting seed. The nuclei for the most part stain very deeply, either wholly, or in several places, although here and there are nuclei which are clear. By the use of a high power this dark staining matter is seen to be distinctly granular (*f.* 2). It stains fully as intensely as chromatin. These granules are often collected in little bunches. Sometimes a string of them lie about the vacuole of the nucleus. The granules seem to arise along the course of the linin network, for many of them may be seen scattered throughout the reticulum. Even at this early stage the nucleus is often so packed with granules that it stains a uniform black and the granular constitution of the mass is shown only by its corrugated edge. In cases where the epidermal cell is double, *i. e.*, where there is an inner and an outer cell, the nuclei of both produce these granules.

Passing now to a kernel that has been placed a little longer in conditions favorable to germination, we find the cytoplasm filled

with these granules and the nucleus empty. Cells that are in an intermediate condition make it clear how this change has taken place. A careful examination of a heavily loaded nucleus will often show a row of granules in the shape of a fine knotted thread extending from the black staining mass in the nucleus through the nuclear membrane and out into the cytoplasm of the cell. There may be several of these threads varying in thickness, but always composed of distinct granules (*f. 3*). Sometimes a thread ends in the cytoplasm in a bunch of granules. As a rule the breaks in the nuclear wall, through which the granules find a point of exit, are very minute, but, in later stages especially, they may be quite extensive (*f. 6*).

In the majority of cases these ruptures seem to be brought about by the constantly increasing size of the mass of granules. Since these granules are present in many nuclei in great abundance before germination has begun, the conclusion is inevitable that they were formed before the resting period. On the other hand, it is no less probable that no diastase is secreted from the cell until the beginning of germination, or, to use Matthew's term, up to that time there is merely "hylogenesis." It is worthy of note, however, that the processes going on at the beginning of germination are a direct continuation of those brought to a stop in the developing embryo by the resting period.

An examination of these same columnar cells in a grain that has been placed under conditions favorable for germination for about 18 hours shows a very striking change in their organization. They are so greatly swollen that they are now at least three times their former size (*f. 4*). The nuclei are for the most part entirely devoid of granules. These have become scattered throughout the cytoplasm, in all probability by virtue of the circulation of the cell sap. Many of the granules have increased considerably in size but the large ones are not restricted to any particular region of the cell. This increase in size of the granules lends color to the theory that a "prozymogen" is formed in the nucleus which becomes an active ferment only after certain elements have been added to it from the cytoplasm.

The nuclei themselves are distorted and in some cases the swelling has been so violent that the delicate nuclear wall is rup-

tured and the nucleolus, vacuole and all, is ejected. The absorption of water by the diastase-secreting cells has, without doubt, caused their swollen condition. This condition, however, is very transitory, for at the end of the first day of germination we find these cells only slightly larger than they were before it occurred. After 24 hours the cells have not only regained their original size, but, in most instances, have also lost their granules. Certain cells are to be found here and there in which the granules are massed together at their ends nearest the endosperm, but otherwise the cytoplasm and nuclei are entirely destitute of them. At the end of the first day, too, the endosperm shows evidence of the action of an enzyme. The solvent action, at this stage, is confined to the cell walls just outside the diastase-secreting epithelium and to the proteid matter between the starch granules. The coincidence of the disappearance of the dark staining granules from the cells that secreted them, and the dissolution of a part of the endosperm, is a strong proof of the diastatic character of the former. By this time the radicle has broken through the coleorhiza and projects for about 1.5 to 2 mm. from the seed.

At the beginning of the second day of germination the diastase-secreting cells are in a resting condition. There is no increase in size and the nuclei and cytoplasm are clear. The solvent effect of the diastase secreted during the first day is now more apparent. Not only are the cell walls in the neighborhood of the epithelium broken down, but the starch grains themselves are pitted. The method of attack of the diastatic enzyme on starch grains has been frequently described and nothing was observed which calls for special mention.

At the end of the second day the epithelial cells again begin to show signs of activity, and the second period of secretion is inaugurated. Dark staining granules have appeared once more in some of the nuclei. These granules steadily increase in quantity until, as before, they completely fill the nuclei. The cytoplasm, however, remains clear of them, and there is no increase in size of the cells themselves until some time during the third day. After about 72 hours of germination, groups of the diastase-secreting cells increase once more threefold in size and the cytoplasmic reticulum is filled with granules precisely as during the first day

(*f.* 5). All the cells, at a given time, are by no means at the same stage in the elaboration of the enzyme. This is especially the case after the first day. We may say, nevertheless, that the first and second periods of secretion are separated by an interval of from 36 to 48 hours. By this time the plumule has broken through, and the radicle is an inch and a quarter in length. The scutellar cells show now a notable increase in the number and size of the starch grains that they contain. This is of course due to the fact that, by virtue of the solvent action of diastase, the starch of the endosperm is being transported and stored up in the scutellum, where it serves as food for the growing plant. The usual reduction in size follows the swollen condition, and is accompanied by a collecting of the granules at the tips of the cells, and finally by a discharge of the enzyme into the endosperm.

From now on until the complete depletion of the endosperm and the final degeneration of the scutellum there are no sudden changes in the size of the secreting cells. There seems, on the other hand, to be a gradual, but steady, increase in size with a continual production of diastase by each cell independently of the others. During the fourth day the nuclei of many cells became filled again with granules and on the fifth these may frequently be seen breaking through the nuclear membrane and collecting at the tips of the cells directly, without at first becoming scattered through the cell (*f.* 6). At the end of 11 days there are signs of degeneration in some of the epithelial cells. These consist of an abnormal swelling and vacuolization of the cytoplasm, most noticeable at the ends of the cells towards the scutellum. After the lapse of 22 days the cytoplasm is very scanty and ragged. The cells have also become very greatly elongated. They are now at least three and a half times their length at the beginning of germination. The cell walls are thick and stratified. The nuclei still stain very darkly and are probably producing a ferment for the dissolution of what is left of the cell walls of the endosperm. The starch grains have completely disappeared from the endosperm and the scutellar cells are mere skeletons (*f.* 7). The time given, at which various changes in the diastase secreting cells occur, is merely approximate and varies greatly according as the conditions are more or less favorable for growth.

A sufficient number of stages in germinating barley have been studied to make it clear that we have the same series of phenomena here during the secretion of diastase as in maize. The granules arise in the nucleus, they find their way into the cytoplasm, and immediately after their disappearance from the cell we note the action of an enzyme on the endosperm. The collecting of the diastase granules at the tip of the cell nearest the endosperm is especially noticeable in barley (*f. 8*).

Although the iron haematoxylin stain is one of the most useful ones for cytological purposes, there is a common source of error in its employment, which should be carefully guarded against. It has a tendency to stain in a very deceptive way any precipitates that may be present in the cell. Such precipitates are easily mistaken for natural metabolic products. Accordingly Auerbach's method was used as a precautionary measure. It is interesting to note that those stages of the nuclei which stain an intense black with iron haematoxylin, also stain very deeply with methyl green; whereas the nuclei with granule-filled cytoplasm stain very lightly with methyl green. This is another proof that matter is ejected from the nuclei at the same time that granules appear in the cytoplasm.

3. *Comparative.*—Very few examples of secreting cells in plants have been studied with any degree of care. The results of Huie and Schniewind-Thies, accordingly, are of especial interest in this connection. Miss Lily Huie ('96) found that during secretion in *Drosera* the basophile cytoplasm was depleted. The basophile chromatin increased in the meantime greatly in extent, and, after ejection from the nucleus, gave rise to new basophile cytoplasm. After long-continued secretion the basophile cytoplasm was entirely replaced by a scanty eosinophile cytoplasm. It was not determined whether the nuclear, or nucleolar chromatin, was the primary product of the metabolism. In diastase-secreting cells the cytoplasm is not so directly concerned in the formation of the secretory product as appears to be the case in *Drosera*. The only evidence of the possible activity of the cytoplasm in the former is the increase in size of some of the granules scattered through it. Schniewind-Thies ('97), who has made a very thorough study of the nectar cells in a number of plants, finds that,

as a rule, at the height of secretion these cells are much swollen. The nucleus becomes greatly enlarged and distorted, often sending out pseudopodial processes. As a general rule there is a loss of staining power in the nucleus during secretion. In the end the cytoplasm is much shrunken and the nucleus and nucleoli completely disappear. The nectar begins to appear at the end or just outside the end of the cell. In this case the nucleus seems to play a very active rôle and bears a strong resemblance to the behavior of the nucleus during the secretion of diastase. In both there is a final disappearance of the nucleus after the cell has exhausted itself by its long-continued secretions. In both also there is a swelling of the cell during the formation of the secretion. It seems not unlikely that this swelling is brought about by osmosis set up by some substance secreted within the cell at this time. The diastase, being of a proteid nature and consequently of high molecular weight, would not be, even if in solution, as active osmotically as other less complex substances, as for instance, organic salts or acids, which, De Vries has shown, exercise a strong osmotic attraction when present in the cell. Nevertheless the swelling takes place when the nucleus has become completely filled with these granules. A possible explanation of this phenomenon may be that some organic acid is formed during the great metabolic activity of the cell. The fact that diastase, in order to be especially effective as a ferment, must be dissolved in a liquid with a distinct, but not too strong acid reaction, lends support to this hypothesis.

A comparison of the secretory processes in plants with those in the animal kingdom, where the literature is much more complete, is certainly of interest. Mathews ('99) has studied the secreting cells of the pancreas very carefully. He describes the pancreas cell as divided into two zones, a granular inner and a striated outer. The fibrils of the outer zone arise in the chromatin and end in the cytoplasm of the inner (granular) zone. "The chromatin has, then, formed a highly complex substance probably a nucleo-albumin (the cell thread or fibril) which splits into at least two constituents, one of which forms the granules, and the other a reticulum. The granular substance is perhaps further altered and ultimately forms the zymogen." The interesting fact from a

comparative standpoint is that, whereas in diastase-secreting cells the ferment is found directly by the nucleus, in the pancreatic cell the nucleus does not play an active rôle, but indirectly controls the zymogenesis. Nevertheless, in both cases the *nucleus* is the ultimate source of the zymogen granules. Mathews, in agreement with Nussbaum, arrives at the rather sweeping conclusion that the changes in the nuclei of the secreting cells are passive, the nuclei taking no active part in secretion or in zymogenesis. The active part taken by the nucleus in the production of the diastase granules certainly forms a very evident exception to this generalization and is a point in favor of the views of Heidenhain, Korschelt and others, who consider that the changes in position and size of the nuclei during secretion are signs of functional nuclear activity.

There is considerable evidence that chromatin is the synthetic substance of the nucleus and in the elaboration of the metabolic products acts somewhat in the manner of a ferment. In other words it brings about the union of certain elements without entering into the synthesis itself, or becoming changed in its chemical nature. Mathews thinks that the fact of the cell threads ending in the chromatin points to this conclusion. The secretion or rather the hylogenesis of diastase seems to be a case exactly to the point, as here the process is strictly intranuclear. Pekelharing ('95) and Halliburton ('95), working from another viewpoint, have demonstrated that fibrin ferment is a nucleo-proteid, a form of chromatin. That the amylolytic granules, while in the nucleus, stain in the same manner and with the same intensity as chromatin, indicates that they have something in common with the fibrin-ferment. According to Macallum the nuclei of the pancreatic cells have much to do with the formation of the enzyme. His experiments lead him to the conclusion that the chromatin elaborates a substance which he calls prozymogen. This finds its way into the cytoplasm and, combining with certain elements, forms the granules of the enzyme; certainly a very good description of the sequence of stages in the diastase cell.

The wide-spread occurrence of granules in secreting cells is worthy of note. Green ('99) giving quite a number of examples in which this is the case. In the mucous glands of the frog's

tongue there is a clear protoplasmic zone and a granular zone; a serous glandular cell is filled with granules during the resting period; a like phenomenon is seen in the pepsin-secreting cells. According to Ward,* during the secretion of rhamnase by *Rhamnus infectorius* granules appear.

In animal tissues the secretions are, as a rule, intermittent, but in plant tissues, according to Green, they are prolonged and probably only to a slight degree intermittent. This he explains by the fact that, in the animal, digestion is continually repeated, whereas in plants the utilization of reserve materials is a continuous and very gradual process. During the first three or four days, however, in the case of maize and probably all the Gramineae there is clearly an intermittence in the secretion of the enzyme.

The active part taken by the nucleus in secretion in plants, at least, is in complete harmony with the view that it is the metabolic center of the cell. Verworn, in his General Physiology, cites a number of instances in which the nucleus takes an active part in the nutrition and growth of the cell. Although, as he observes, the presence of a membrane generally necessitates the exchange of liquids between nucleus and protoplasm, yet many observers, among them Fromman and Auerbach, "have observed on the part of the nucleus a direct ingestion and extrusion of granules and flakes." The ejection of granules from the nucleus of the diastase-secreting cell is another case to the point.

A general review of the literature on secretion in plants and animals leads one to the conclusion that in the two cases we have a different state of affairs. In both the nucleus is the ultimate source of the secretory product but in plants it is far more directly concerned than in animals; in the one it is active and in the other passive.

GENERAL CONCLUSIONS

1. In the Gramineae "diastase of secretion" arises in the nucleus of the epidermal cells of the scutellum. For:

(*a*) At the beginning of germination the nuclei contain dark staining granules, but there are few or none in the cytoplasm.

(*b*) At this same stage, through very small breaks in the membranes of the heavily loaded nuclei, granules are beginning to exude in small streams.

* Green, R., Soluble Ferments and Fermentation, 379.

(*c*) These granules at first spread through the cell but later collect at the end of the cell next to the endosperm, where they are ultimately dissolved.

(*d*) Immediately after their dissolution the first destructive action of a ferment in the cell walls and inter-starch matrix of the endosperm is to be observed.

(*e*) Soon starch grains appear in greater abundance in the scutellar cells.

2. Zymogenesis begins in the nuclei before the advent of the resting period.

3. At some time during the first and third days of germination the diastase-secreting cells swell to three or four times their original size.

4. During the first and third days there are "waves" of secretion, so that this process may be described as intermittent. From that time on, until the final exhaustion of the cells, the secretion is more continuous. (It has been shown by Hansteen * that an accumulation of diastase unless removed will inhibit the further secretion of that substance by the scutellum and it would seem that the behavior of the secreting cells as above described is due to this fact.)

5. The secreting cells begin to degenerate about the tenth day.

6. It is highly probable that the chromatin takes an active part in the zymogenesis.

7. The nucleus is in this case very clearly the metabolic center of the cell.

8. There is a marked difference in secretory processes in plants and animals.

COLUMBIA UNIVERSITY.

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* See Pfeffer's Physiology of Plants (English translation), p. 580.

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Explanation of Plate 20

FIG. 1. A somewhat diagrammatic view of a section of a kernel of corn, showing the general relationship of the plantlet, the scutellum, and the endosperm: *end*, endosperm; *ep*, secreting epithelium of scutellum; *pl*, plumule; *r*, radicle; *sc*, scutellum with the vascular tissue. ×4.

FIG. 2. Diastase-secreting cells before the beginning of germination: *end*, endosperm; *ep*, diastase-secreting cells; *d*, diastase granules; *n*, nucleus; *sc*, scutellar cells; *st*, starch grains. ×795.

FIG. 3. Shortly after the beginning of germination: *d*, diastase granules. × 795.

FIG. 4. The same cells the latter part of the first day of germination. The firs period of secretion: *d*, diastase granules; *n*, nucleus. × 795.

FIG. 5. The condition of the cells after about three days of germination; corrosion of starch grains; *st*, starch grains; *d*, diastase granules. × 795.

FIG. 6. Diastase-secreting cells during the fifth day of germination. × 795.

FIG. 7. The extremely elongated diastase-secreting cells after about twenty-two days of germination. × 795.

FIG. 8. The corresponding cells of barley during secretion of the enzyme. The seeds had germinated about two days. × 795.

All figures except the first were drawn from camera outlines.

A historical Review of the proposed Genera of the Hydnaceae

By Howard J. Banker

The family of the Hydnaceae is distinguished from all other families of the Basidiomycetes by the fact of the hymenial surface being developed in the form of subulate or awl-shaped spines or teeth. This characteristic renders it comparatively easy to distinguish most members of the group. Yet there are species that grade insensibly into related families, so that it is impossible to draw hard and fast lines here as much as in any part of the plant world; thus through the genera *Sistotrema* and *Irpex* we may pass by a natural transition to the family Polyporaceae, or, choosing a different route, we may make the transition just as naturally through the genera *Phlebia* and *Merulius;* on the other hand we may pass with equal ease to the Thelephoraceae through *Grandinia* and *Thelephora*, while the transition to the Clavariaceae is not likely to prove any more difficult.

The earliest reference we have to a plant of the hydnaceous type appears to have been by Bauhin, in 1651, in his Historiae Plantarum Universalis, **3**: 828. As the reference is brief I quote it in full as a matter of curiosity, and as giving the historical origin of this group of plants:

"Fungus paene candidus prona parte erinaceus. Raro naturae miraculo parte prona pro membranulis innumeris veluti aculeis muricatus, erinaceum in memoriam revocat, unde ex argumento nomen imposuimus." It is entirely probable that the plant thus referred to was *Hydnum repandum.*

For the next century the group received little attention from botanists, and at the publication of the Species Plantarum in 1753 but four plants had become distinguished in botanical literature. During the past century and a half the group has grown to quite ample proportions, constituting the distinct family Hydnaceae and embracing more than 450 species as recognized in Saccardo's Sylloge Fungorum. From this material numerous genera have been proposed with more or less substantial claims to validity. It

is the purpose of this paper to review these claims chiefly from a historical standpoint, believing it will serve to clear the air for a more critical study of generic relationships in this family. Before entering upon this discussion it will be proper to state the most important principles by which it is proposed to determine the historical status of a generic name.

This much vexed question is still in a very unsettled state, but it does not seem advisable to take up the space of this paper by a full discussion of the principles here adopted. In general they will be found to conform closely to those set forth by Professor L. M. Underwood in his paper "A Review of the Genera of Ferns proposed prior to 1832." *

1. Only generic names established in Linnaeus' Species Plantarum, 1753, or later are considered.†

2. No generic name is considered as established unless it is: (*a*) Associated with one or more previously described species which are referred to with sufficient directness as to be recognizable, or (*b*) Associated with some species which is described for the first time at the publication of the name itself. Generic names founded with no hint of a species with which the name can be permanently associated will not be considered as holding any priority rights against names capable of being anchored to definite species (*cf.* Underwood, *l. c.*).

3. Whenever a genus is established under a new generic name the name will be considered as permanently associated with the first-named species in the genus. This does not constitute such "first-named species," the *type* of the genus in any sense that involves the primary meaning of that term.‡ Nevertheless, the distinct designation of some other species as the "type" of his genus by the author will be considered a sufficient ground for an exception to the above rule.

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* Mem. Torrey Club, **6**: 250.

† This rule, laid down by the Rochester convention, compels us to ignore the older and more appropriate name *Erinaceus* for the leading genus of the family.

‡ This is the key to my modification of Underwood's rules. I have sought to avoid every expression that seemed to involve the idea of "type species," believing there is an ambiguity in the conception to which is to be attributed much of the controversy that rages about this term. Moreover it does not seem to me possible to determine the true biological type of any genus in the present state of our knowledge.

As this paper is not intended to be a criticism of nomenclature it is not necessary to present further rules or to discuss the details of this subject. Therefore, with these principles as a guide, we will examine the genera which have been proposed in this family.

1. HYDNUM L. Sp. Pl. 1178. 1753

The genus was founded on four species, namely *H. imbricatum*, *repandum*, *tomentosum*, and *Auriscalpium* in the order named. It is to be observed that all these species, the only members of the family known to Linnaeus, are stipitate forms. The form *Hydna* was first used. In Flora Lapponica, 368, 1737, Linnaeus published the genus *Hydna* with two species which, from the descriptions there given and from his own citations in Sp. Pl. **2**: 1178. 1753, are clearly *H. imbricatum* and *H. Auriscalpium* respectively. In Genera Plantarum, 327, also published in 1737, he publishes the genus *Hydna* without naming any species but cites "*Erinaceus* Dill." Now Dillenius, Catalogus Plantarum circa Gissam nascentium 188, *pl. 1.* 1719, figures and describes but one species which is evidently *H. repandum*. Linnaeus also clearly so understood it, for in Sp. Pl. **2**: 1178 under *H. repandum* he cites "Flora Suecica, 1098," and in the last-named reference he cites again "Dill. giss. 188." It may therefore be considered an open question whether we are to regard *H. imbricatum* or *H. repandum* as the species with which the generic name is to be permanently associated, that is, to constitute the so-called "type." The technical decision must turn upon the determination whether the "Flora Lapponica" or the "Genera Plantarum" both of which bear the date 1737, was published first. But this is a laborious quibbling over trifles. Linnaeus originated the genus himself, and it is evident from his lists that *H. imbricatum* ever stood foremost in his mind as the leading representative of his genus. In his Systema Naturae, 32. 1740, he changed the form of the name to *Hydnum*. Therefore the generic name *Hydnum* belongs permanently to *H. imbricatum* and becomes the proper name of the genus to which that species is referred.

2. SISTOTREMA Pers. Neues Mag. für die Bot. **1**: 108. 1794

The genus was founded on *S. confluens* Pers. (= *Hydnum sublamellosum* Bull.) and *S. cinereum* Pers.

3. HERICIUM Pers. Neues Mag. für die Bot. 1 : 109. 1794

This genus was established on *Hydnum coralloides* Schaef., a single species and is not *Hericium* of Fries, *q. v.*

4. ODONTIA Pers. Neues Mag. für die Bot. 1 : 110. 1794

This genus was established on *O. ferruginea* Pers. and *O. nivea* Pers. and is not the *Odontia* of Fries, *q. v.*

5. XYLODON S. F. Gray, Nat. Arr. Brit. Pl. 1 : 649. 1821

This name was first given to a subgenus of *Sistotrema* by Persoon in Syn. Fung. 552. 1801. It included *Odontia quercina* Pers. and six other species. Gray made it a genus of his family of the Sistotremideae with the species *Sistotrema quercina* Pers. and *S. digitatum* Pers. It has since been treated, when recognized, as a genus of the Polyporaceae, where it presumably belongs. It has been included here only to make the historical discussion of the family complete.

6. DENTINUM S. F. Gray, Nat. Arr. Brit. Pl. 1 : 650. 1821

The genus was founded on *Hydnum repandum* L. and *H. rufescens* Pers.

7. AURISCALPIUM S. F. Gray, Nat. Arr. Brit. Pl. 1 : 650. 1821

The genus was based on *Hydnum Auriscalpium* L., a single species.

8. STECCHERINUM S. F. Gray, Nat. Arr. Brit. Pl. 1 : 651. 1821

This genus was established on *Hydnum Daviesii* Sow. (= *H. ochraceum* Pers.*), *H. gelatinosum* Pers. and *S. quercinum* Gray (= *Hydnum erinaceus* Bull.). In his Key, on page 597, Gray uses the form *Stecherina* but, as he quotes Micheli for the source of the name, it is evident that the form used in the text is the correct one.

* Gray quotes *Hydnum ochraceum* Pers. as a synonym. *H. Daviesii* was figured and named by Sowerby in Eng. Fungi, 15. 1797. The same species was described under the name of *H. ochraceum* by Persoon in Obs. Myc. 1 : 73. 1796, and he quotes as reference "Gmel. Syst. Nat. Linn. 2 : 1440." The copy of Gmelin in the Library of the New York Botanical Garden is dated 1796 and on page 1440 is given "*H. ochraceum* Pers." but without any reference, the preceding species, however, is given as "*H. mucidum* Persoon fung. ined." It is evident, therefore, that *H. ochraceum* Pers. was first published in Gmelin, Syst. Nat. Linn. 2 : 1440, at least as early as 1796, but Pritzel's Thesaurus gives 1791, as the date of Gmel. 2. In this case, however, this difference in date is not important as even the later establishes Persoon's priority. It would be a matter of interest to know the ground of Pritzel's earlier date.

9. PHLEBIA Fr. Syst. Myc. 1: 426. 1821

The genus was founded on *Merulius merismoides* Fr. with three other species.

10. RADULUM Fr. Syst. Orb. Veg. 81. 1825

This genus was established on *Hydnum pendulum* (= *Sistotrema pendulum* Alb. & Schw.) with three other species. That the species, simply named as *Hydnum pendulum* by Fries, in this instance is really *Sistotrema pendulum* of Albertini and Schweinitz is made unquestionably evident by a comparison of the text in Systema Orbis Vegetabilis, 81, with the text in the Conspectus Fungorum, 261. Fries himself always cites the Elenchus Fungorum, 149. 1828, as the place where he established the genus. But this must be regarded as a different genus having the same name, for, curiously enough, in the latter work, he describes a totally different species and evidently a new one under the name of *pendulum*. *Cf. Irpex* below.

The name *Radulum*, however, is untenable, being excluded by *Radula*, established as a genus of the Jungermaniaceae, by Dumortier in Comment. Bot. Obs. 112. 1822.* I propose, therefore, for the name of this genus **Tylodon** † based on **T. Friesii** (= *Radulum pendulum* Fries, Elenchus Fungorum, 149. 1828; not *Radulum pendulum* Fries, Syst. Orb. Veg. 81. 1825.)

11. IRPEX Fr. Elench. Fung. 142. 1828

This genus was first published by Fries in Syst. Orb. Veg. 81. 1825; but without naming any species. In the Elenchus, 142, ten species are mentioned under *Irpex*, *I. pendulus* standing first. This species is clearly our old friend of the *Radulum* discussion, *Sistotrema pendulum* Alb. & Schw., as may be seen by a comparison of Elench. Fung. 142, with Syst. Myc. 1: 413. A more curious confusing of names it would seem could hardly be found in the work of a great systematist.

The genus stands on the border line between the Hydnaceae and the Polyporaceae and is thrown now to the one side and now to the other by the varying judgment of mycologists.

* *Cf.* M. A. Howe, Hepaticae and Anthocerotes of California, Mem. Torrey Club, 7: 157, note.

† From τύλη, a knot or callus, and ὁδούς.

12. HERICIUM Fr. Syst. Orb. Veg. 88. 1825

The name was published in the above work without any species being given, but a reference is made to Syst. Myc. 1 : 409. 1821, "Hydna Gomphi." In the latter work, under the section Gomphi, four species are described : *Hydnum Caput-medusae*, *H. hystrix*, *H. echinus* and *H. ramularia ;* we must therefore regard these as representing *Hericium* Fr. That the genus, moreover, is distinct from *Hericium* Pers. is positively established by Fries' own comment in Syst. Orb. Veg. 88. "Cum *Hericio* Pers., cujus typus *H. coralloides* * * * non commutandum." In Hym. Eur. 617. 1874, Fries retains only two of the original species, *H. hystrix* and *H. echinus*, while a wholly new species stands at the head of the list, *H. Notarisii*. Although the name is untenable, it does not seem wise to propose a new one until the validity of the species composing it is more thoroughly established.

13. ODONTIA Fr. Epicrisis, 528. 1836–8

Fries based this genus on five species of which *Hydnum barba-Jovis* Bull. stands first, but of one of the following species, *O. fimbriata*, he says "typus generis." Fries first published the name in Obs. Myc. 149. 1815, as a subgenus of *Hydnum* with three species; *Hydnum pinastri* Fr. standing first and *fimbriata* not being mentioned.

Fries' name of *Odontia*, however, is preoccupied by *Odontia* Pers., which evidently stands for a very different group. I, therefore, propose the name **Etheirodon** * based on **E. fimbriatum** (= *Odontia fimbriata* Fries, Epicrisis, 528).

The Friesian groups of *Hericium* and *Odontia* are the ones commonly known by these names and not the older genera of Persoon. The discussion of the above four genera well illustrates the loose methods of nomenclature formerly in vogue.

14. GRANDINIA Fr. Epicrisis, 527. 1836–8

This genus was established on *G. polycocca* Fr. with six other species.

15. KNEIFFIA Fr. Epicrisis, 529. 1836–8

This was established on *Thelephora setigera* Fr. (= *Th. aspera* Pers.).† The name is untenable, having been used by Spach in

* From ἔθειρα, a tuft of hair, and ὀδούς, tooth.

† Bull. Torrey Club, **25** : 631. 1898.

Hist. Nat. Veg. **4**: 373. 1835, for a genus of the Epilobiaceae. For this reason Underwood proposed the name *Kneiffiella* in Bull. Torrey Club, **24**: 205. 1897. The next year P. Hennings independently proposed precisely the same name, Die nat. Pflanzenf. **1**[1**]: 139. 1898. But this name was found to be untenable, having been used by Karsten for another genus of the Hydnaceae, Krit. Ofv. Finlands Basids. 371. 1889. Underwood then proposed the name *Pycnodon*, Bull. Torrey Club, **25**: 631. D. 1898. But this name had been anticipated four months previously by Saccardo, who had published the name *Neokneiffia* in his Tab. Com. Gen. Fung. 11 Aug. 1898. Nunc requiescat in pace!

16. MUCRONIA Fr. Summa Veg. Scand. 329. 1849

The genus was based on *Hydnum calvum* Alb. & Schw., a single species. The name was found to be preoccupied by Bentham for a genus of the Polygonaceae, Trans. Linn. Soc. **17**: 419. 1837. Fries himself, therefore, changed the name to *Mucronella*, Hym. Eur. 629. 1874.

17. GRAMMOTHELE Berk. & Curtis, Jour. Linn. Soc. **10**: 327. 1869

The genus was established on *G. lineata* with three other species.

18. MUCRONELLA Fr. Hym. Eur. 629. 1874

This name was proposed as a substitute for *Mucronia* (*q. v.*) and is, therefore, based on *Hydnum calvum* Alb. & Schw.

19. SARCODON Quel. Clavis Hym. 195. 1878

This genus was established on *Hydnum imbricatum* L. with eighteen other species. The name is clearly a direct synonym of *Hydnum* L.

20. CALODON Quel. Clavis Hym. 196. 1878

Quelet established this genus on *Hydnum suaveolens* Scop. with twenty-one other species.

21. DRYODON Quel. Clavis Hym. 198. 1878

The genus was founded on *Hydnum umbellatum* March. with seven other species including *Hydnum coralloides* Schaef. on which Persoon had based his genus *Hericium*. *Dryodon* Quel. must, therefore, be considered a synonym of *Hericium* Pers.

22. PLEURODON Quel. Clavis Hym. 198. 1878

The genus was established on *Hydnum occidentale* Paul. with seventeen other species.

23. HYDNUM Quel. Clavis Hym. 200. 1878

Quelet published this name with thirty-one species, all resupinate in form, not one of which we have any reason to suppose was known to Linnaeus. No law of nomenclature would seem to justify one in regarding such a group as *Hydnum* L.* *Hydnum* Quel. must be considered as a distinct idea from *Hydnum* L. and the name, therefore, preoccupied by Linnaeus.

In a later work, the Enchiridion Fungorum, 1886, Quelet has wholly ignored any such genus as *Hydnum;* the species of his own genus of that name being referred almost bodily to the genus *Odontia* Pers., and the name of the family itself being changed from Hydnaceae to Erinaceae.

24. AURISCALPIUM Karst. Medd. Soc. Faun. et Fl. Fenn. **5**: 27. 1879

This name was published with *A. vulgare* (= *Hydnum Auriscalpium* L.) and two other species. It is a direct synonym of *Auriscalpium* Gray, *q. v.*

25. HYDNELLUM Karst. Medd. Soc. Faun. et Fl. Fenn. **5**: 27. 1879

This genus was founded on *Hydnum suaveolens* Scop. with eighteen other species. The name is a synonym of *Calodon* Quel. *q. v.*

26. GLOIODON Karst. Medd. Soc. Faun. et. Fl. Fenn. **5**: 28. 1879

The genus was established on *Hydnum strigosum* Sw. with two other species.

27. FRIESITES Karst. Medd. Soc. Faun. et Fl. Fenn. **5**: 27. 1879

The genus was established on *Hydnum coralloides* Scop. (= *H. coralloides* Schaef.) and *H. caput-ursi* Fr., so the name is a synonym of *Hericium* Pers.

* Karsten has performed the same sort of nomenclatural gymnastics by publishing the genus *Hydnum* with five resupinate species and then added the star feature of quoting the name of the genus as "*Hydnum* Linn."! *Cf. Hydnum* page 438.

28. CREOLOPHUS Karst. Medd. Soc. Faun. et Fl. Fenn. **5**: 27. 1879

This genus was based on *Hydnum corrugatum* Fr. and three other species.

29. CALDESIELLA Sacc. Michelia, **1**: 7. 1879

This genus was established on *C. Italica*, a single species, and placed in the Gasteromyceteae. Saccardo transferred it afterward to the Hydnaceae in Sylloge Fungorum, **6**: 477 and conveys an impression of uncertainty as to its true status in his account.

30. ACIA Karst. Medd. Soc. Faun. et Fl. Fenn. **5**: 28. 1879

The genus was founded on *Hydnum fusco-atrum* Fr. with thirty other species. The name is untenable, as it is preoccupied for a genus of the Rosaceae, by Schreber, Gen. Plant. **2**: 458. 1791.

31. LOPHARIA Kalch. & MacOwan, Grevillea, **10**: 58. 1881

The genus was published with *L. lirillosa*, a single species.

32. TYRODON Karst. Rev. Myc. **3**: 19. 1881

The genus was founded on *Hydnum repandum* L. and *H. rufescens* Pers. and is, therefore, a direct synonym of *Dentinum* Gray. Karsten evidently has had no knowledge of Gray's work which has been sadly neglected even by Gray's own countrymen.

33. PHELLODON Karst. Rev. Myc. **3**: 19. 1881

This genus was established on *Hydnum nigrum* Fr. with two other species.

34. CLIMACODON Karst. Rev. Myc. **3**: 20. 1881

The genus was established on *Hydnum septentrionale* Fr., a single species.

35. LEPTODON Quel. Ench. Fung. 191. 1886

The genus was based on *Hydnum occidentale* Paul. with eight other species. In accordance with the rules laid down, this name must be regarded as a synonym of the author's own genus *Pleurodon*. We have less compunction in the rigid application of our rule in this case, since there is no evidence that Quelet was governed by any rules whatever in his own work.

36. ODONTINIA Pat. Hym. D'Eur. 147. 1887

The genus was established on *Hydnum denticulatum* Pers. with four other species.

37. PHAEODON Schroet. Krypt. Flora Schlies. **3**: 458. 1888

The genus was established on *Hydnum tomentosum* * Schrad. with eight other species. *H. tomentosum* Schrad. is the same as *Odontia ferruginea* Pers., and hence *Phaeodon* Schroet. must be treated as a synonym of *Odontia* Pers.

38. GRANDINIA Schroet. Krypt. Fl. Schles. **3**: 450. 1888

This genus was based on *Odontia crustosa* Pers. with *G. alutacea;* it is to be regarded as equivalent to *Grandinia* Fr.; otherwise the name is untenable.

39. KNEIFFIELLA Karst. Finlands Basids. 371. 1889

The genus was established on *Hydnum barba-Jovis* Bull., a single species.

40. SCLERODON Karst. Finlands Basids. 360. 1889

The genus was established on *Hydnum strigosum* Sw., a single species. Karsten quotes *Gloiodon* in the above reference as a synonym of *Sclerodon.* But the rules of priority compel us to regard *Sclerodon* as a direct synonym of *Gloiodon.*†

41. AMAURODON Schroet. Krypt. Fl. Schles. **3**: 461. 1889

This genus was founded on *Sistotrema viride* Alb. & Schw. a single species.

42. THWAITESIELLA Massee, Grevillea, **21**: 2. 1892

The genus was based on *T. mirabilis* (= *Radulum mirabile* B. & Br. Jour. Linn. Soc. **14**: 61. 1875). A single species. Patouillard has demonstrated that the genus is identical with *Lopharia* Kalch. & MacOwan and should be regarded as a synonym of the latter.‡

43. ASTERODON Pat. Bull. Soc. Myc. **10**: 129. 1894

The genus was established on *A. ferruginosum,* a single species.

* This name is untenable, having been used by Linnaeus for a stipitate species in Sp. Pl. **2**: 1178. 1753.

† This is a case that would seem to justify a method of residues in the determination of "types." But it seems to us a very exceptional case.

‡ Bull. Soc. Myc. France **11**: 13. 1895.

44. GRANDINIELLA Karst. Hedwigia, **34**: 8. 1895

The genus was founded on one species, *G. livescens*.

45. HYDNELLUM Karst. Hedwigia, **35**: 173. 1896

The genus was founded on *Kneiffia subtilis* Karst., a single species. The name is untenable, having been used by Karsten himself as the name of a mesopous genus in this same family, a synonym of *Calodon* Quel.

46. HYDNOCHAETE Bres. Hedwigia, **35**: 287. 1896

This genus was established on one species, *H. badia*.

47. HYDNOCHAETE Peck, Reg. Rep. **50**: 113. 1897

The genus was established on *H. setigera*, a single species. The name is preoccupied by Bresadola as above.

48. KNEIFFIELLA Underw. Bull. Torrey Club, **24**: 205. 1897

49. KNEIFFIELLA Henn. Die nat. Pflanzenf. **1**^{1**}: 139. 1898

50. NEOKNEIFFIA Sacc. Tab. Com. Gen. Fung. 11. 1898

51. PYCNODON Underw. Bull. Torrey Club, **25**: 631. 1898

The above four names were successively proposed as substitutes for *Kneiffia* Fr. *q. v.* *Neokneiffia* prevails.

52. HYDNOCHAETELLA Sacc. Tab. Com. Gen. Fung. 11. 1898

This name was proposed as a substitute for *Hydnochaete* Peck and is therefore based on *H. setigera* Peck.

53. ECHINODONTIUM Ellis & Everh. Bull. Torrey Club, **27**: 49. 1900

This genus was established on the single species, *Fomes tinctorius* E. & E.

SUMMARY

To sum up then, we have the following names for the genera of the Hydnaceae with their synonyms. It is probable that several of these will be reduced to synonymy when a proper arrangement of the groups is obtained.

Names free to be used are in full face; synonyms in Roman; the species with which the generic name is to be permanently associated follows the date in Italics.

Acia Karst. 1879, name preoccupied.
Amaurodon Schroet. 1889. *Sistotrema viride* Alb. & Schw.
Asterodon Pat. 1894. *A. ferruginosum* Pat.
Auriscalpium S. F. Gray, 1821. *Hydnum Auriscalpium* L.
Auriscalpium Karst. 1879. *A. vulgare* Karst. = *Hydnum Auriscalpium* L.
Caldesiella Sacc. 1879. *C. italica* Sacc.
Calodon Quel. 1878. *Hydnum suaveolens* Scop.
Hydnellum Karst. 1879. *Hydnum suaveolens* Scop.
Climacodon Karst. 1881. *Hydnum septentrionale* Fr.
Creolophus Karst. 1879. *Hydnum corrugatum* Fr.
Dentinum S. F. Gray, 1821. *Hydnum repandum* L.
Tyrodon Karst. 1881. *Hydnum repandum* L.
Dryodon Quel. 1878 = Hericium.
Echinodontium Ell. & Ev. 1900. *Fomes tinctorius* Ell. & Ev.
Etheirodon gen. nov. *Odontia fimbriata* Fr.
Odontia Fr. 1836–8. *O. fimbriata.*
Friesites Karst. 1879 = Hericium.
Gloiodon Karst. 1879. *Hydnum strigosum* Sw.
Sclerodon Karst. 1889. *Hydnum strigosum* Sw.
Grammothele Berk. and Curt. 1869. *G. lineata.*
Grandinia Fr. 1836–8. *G. polycocca.*
Grandiniella Karst. 1895. *Gr. livescens.*
Hericium Pers. 1794. *Hydnum coralloides* Schaef.
Dryodon Quel. 1878. *Hydnum umbellatum* March.
Friesites Karst. 1879. *Hydnum coralloides* Schaef.
Hericium Fr. 1825; name untenable.*
Hydnellum Karst. 1879 = Calodon.
Hydnellum Karst. 1896; name preoccupied.
Hydnochaete Bres. 1896. *H. badia.*
Hydnochaete Peck, 1897 = Hydnochaetella.
Hydnochaetella Sacc. 1898. *Hydnochaete setigera* Peck.
Hydnochaete Peck, 1897. *H. setigera.*
Hydnum L. 1753. *H. imbricatum.*
Sarcodon Quel. 1878. *Hydnum imbricatum* L.
Hydnum Quel. 1878; name preoccupied.

* The species are doubtful and do not warrant a substitution.

Irpex Fr. 1828. *Sistotrema pendulum* Alb. & Schw.
Radulum Fr. 1825. *Sistotrema pendulum* Alb. & Schw.
Kneiffia Fr. 1836–8 = Neokneiffia.
Kneiffiella Karst. 1889. *Hydnum barba-Jovis* Bull.
Kneiffiella Underw. 1897 = Neokneiffia.
Kneiffiella Henn. 1898 = Neokneiffia.
Leptodon Quel. 1886 = Pleurodon.
Lopharia Kalch. & MacOwan 1881. *L. lirillosa.*
Thwaitesiella Massee 1892. *Radulum mirabilis* B. & Br.
Mucronella Fr. 1874. *Hydnum calvum* Alb. & Schw.
Mucronia Fr. 1849. *Hydnum calvum* Alb. & Schw.
Neokneiffia Sacc. 1898. *Thelephora aspera* Pers.
Kneiffia Fr. 1836–38. *Thelephora aspera* Pers.
Kneiffiella Underw. 1897. *Thelephora aspera* Pers.
Kneiffiella Henn. 1898. *Thelephora aspera* Pers.
Pycnodon Underw. 1898. *Thelephora aspera* Pers.
Odontia Pers. 1794. *O. ferruginea.*
Phaeodon Schroet. 1888. *Odontia ferruginea* Pers.
Odontia Fr. 1836–8; name preoccupied.
Odontinia Pat. 1887. *Hydnum denticulatum* Pers.
Phaeodon Schroet. 1888 = Odontia Pers.
Phellodon Karst. 1881. *Hydnum nigrum* Fr.
Phlebia Fr. 1821. *Merulius merismoides* Fr.
Pleurodon Quel. 1878. *Hydnum occidentale* Paul.
Leptodon Quel. 1886. *Hydnum occidentale* Paul.
Pycnodon Underw. 1898 = Neokneiffia.
Radulum Fr. 1825 = Tylodon.
Sarcodon Quel. 1878 = Hydnum.
Sistotrema Pers. 1794. *Hydnum sublamellosum* Bull.
Sclerodon Karst. 1889 = Gloiodon.
Steccherinum S. F. Gray, 1821. *Hydnum ochraceum* Pers.
Thwaitesiella Mass., 1892 = Lopharia.
Tylodon gen. nov. *T. Friesii.*
Radulum Fr. 1830. *R. pendulum* (*cf.* page 440).
Tyrodon Karst. 1881 = Dentinum.
Xylodon S. F. Gray, 1821. *Sistotrema quercina* Pers.

CALIFORNIA, PA.

Mycological Notes and new Species

By C. L. Shear

Fusicladium fasciculatum C. & E. Grevillea, **6**: 88. Mr. 1878

A careful study and comparison of authentic specimens of this species, issued by Ellis in North American Fungi no. 545, with *Scolecotrichum euphorbiae* Tracy & Earle, Bull. Torrey Club, **23**: 209. May 1896, as represented in the herbarium of the Department of Agriculture by specimens marked "type material" and sent by Tracy and Earle shows that they are the same species. Both are on stems and leaves of *Euphorbia*. The form on stems, N. A. F. 545, appears more effuse than that on leaves, Fungi Col. 380, which is identical with the Tracy & Earle material. The conidia vary considerably in size. The effuse form, N. A. F. 545, has conidia 9–16 × 5–7 μ. Tracy & Earle's specimen has somewhat larger conidia, varying from 13–22 × 6–8 μ. As pointed out by Tracy & Earle this is not a typical *Scolecotrichum* in the sense in which the genus is defined by Saccardo. What the typical *Scolecotrichum* of Kunze & Schmit, Myc. Heft **1**: *pl. 1. f. 5.* 1817, is does not, however, seem very clear. It is a monotypic genus, the authors having referred to it only one species, *S. virescens*, which is rather indefinitely described and poorly figured. Unless specimens of the type are extant it is doubtful whether the genus can stand.

The plant under discussion belongs however, to the group to which this generic name is at present applied rather than to *Fusicladium* and unless there is an older tenable name should be designated **Scolecotrichum fasciculatum** (C. & E.).

Lachnum Engelmanni Tracy & Earle, Pl. Bak. **1**[1]: 25. 1901

An examination of this species as represented by type material (no. 1058 Baker, Earle & Tracy on *Picea Engelmanni*, La Plata Mts., Colo.) seems to indicate that it is identical with *Peziza* (*Dasyschyphae*) *arida* Phill. Grevillea, **5**: 117. *pl. 89. f. 13.* 1877.

We have had no opportunity to examine type material of Phillips' species, which was collected by Harkness & Moore on

pine bark in the Sierra Nevada mountains, but his description and plate agree so closely with these specimens and with other material determined by Ellis and Rehm that there seems little doubt about the matter. Ellis issued the species (no. 1246 N. A. F. on bark of *Abies Menziesii* from Colorado) as *Peziza fuscosanguinea* Rehm, but Dr. Rehm does not regard it as his species. The typical plant, so far as agreement with Phillips' description and figure goes, was issued by the writer in F. Col. no. 1414. It was collected in the Powder River Mountains of eastern Oregon, growing abundantly on the bark of recently cut pines. The plant is rather frequent on bark of various dead conifers in the West, especially in subalpine regions.

Cryptoporus gen. nov.

Cryptoporus Peck as a section of *Placodermei* of the genus *Polyporus*, Bull. Torrey Club, **7**: 104. Oct. 1880.

The type of the genus is **Cryptoporus volvatus** (Peck). *Polyporus volvatus* Peck, Rep. N. Y. St. Mus. **27**: 98. *pl. 2. f. 3–6.* 1875.

Three varieties were described by Professor Peck, only one of which appears to us of varietal importance, **Cryptoporus volvatus Torreyi** (Ger.). *Polyporus volvatus Torreyi* Gerard, Bull. Torrey Club, **7**: 104. *f. 1–3.* O. 1890.

This fungus is so different from any other *Polyporus*, especially in the thick volva-like extension of the margin of the pileus which covers the pores with the exception of a small circular aperture, as to deserve in our opinion generic rank. Professor Peck, *l. c.*, has given a very full description of the fungus to which we need only add the following extension of range and new hosts:

Vicinity of Washington, D. C., on *Pinus Virginiana*, collected by the late G. H. Hicks, also by the writer.

Grand Lake, Colorado, on *Pinus contortus Murrayana*, no. 1107, Shear & Bessey.

Blue Mountains, Oregon, on undetermined conifer, collected by the writer, 1899.

Secotium Arizonicum Shear & Griffiths sp. nov.

Peridium subglobose to subpyriform, pale yellowish-white, smooth, 2–4 cm. high × 1.5–3 cm. in diameter, rather thin and

fragile when dry, sessile or occasionally very short stipitate, rupturing more or less irregularly in longitudinal slits from the apex; columella not well developed, usually not reaching the apex of the peridium; gleba composed of closely anastomosing thin plates forming more or less elongated longitudinal cells, pale sulphur yellow when dry, becoming slightly brownish at maturity; spores spherical or subspherical, pale creamy white, smooth, guttulate, 8–12 μ diam., frequently with a very short pedicel.

Type no. 1630, D. Griffiths, mesa near Tucson, Arizona, Sept. 1900. Type material also distributed in Griffiths, West American Fungi, no. 323.

This species seems more nearly related to *S. Warnei* Pk. than any other known species. It differs, however, in its much smaller size, different mode of dehiscence and lighter colored peridium and gleba, as well as in the poorly developed columella which appears to but rarely, if ever, reach the apex of the peridium and is sometimes almost or quite lacking.

Scleroderma pteridis sp. nov.

Peridium globose or depressed-globose, sessile, sordid white or faintly yellowish, irregularly squamose, fibrose-radicate, 3–6 cm. diameter; wall 3–8 mm. thick, separating from the gleba in drying; gleba firm, somewhat indistinctly areolate, purplish-brown; columella none; spores irregularly globose, purplish-brown, roughened with short spines, 6–8 μ diameter.

Growing attached to dead rhizomes of *Pteris aquilina* in the side of a recent excavation, two to four feet below the surface and embedded in the earth.

Type no. 1115 collected by the writer, wagon road near Baker Creek, six miles west of McMinnville, Oregon, July, 1899.

The plant seems most nearly related to *Scleroderma Geaster*. None of the specimens were entirely mature so that the method of dehiscence is uncertain; but the peridium is much thicker and the spores smaller and lighter colored than in *S. Geaster*. The plant is remarkable on account of its subterranean habit and its connection with the rhizomes of *Pteris*.

Cucurbitaria celtidis sp. nov.

Perithecia .35–.5 mm. in diameter, densely gregarious or subcespitose, covering continuous areas of dead branches, erumpent or partially immersed in the bark, depressed globose, carbonaceous,

somewhat granular roughened, frequently partially collapsed, provided with a papilliform ostiolum; asci cylindric, short-stipitate or subsessile, 140–180 × 16 μ; sporidia uniseriate, overlapping somewhat, hyaline at first then yellowish and finally dark brown, with 3–5 transverse septa and one longitudinal septum, slightly constricted at the septa, 24–27 × 8 μ; paraphyses branched above, equally or exceeding the asci and about 3 μ in diameter.

Type material, no. 383, collected by the writer on dead branches of *Celtis occidentalis*, Osborne, Kansas, March, 1894. The plant is scarcely a typical *Cucurbitaria* and was at first referred to *Teichospora*, but I have referred it to the former genus in deference to the opinion of Dr. Rehm to whom specimens were submitted.

Fusicladium robiniae sp. nov.

Hypophyllous or sometimes amphigenous; spots reddish-brown, usually numerous, scattered, .5–1.5 mm. diam., circumscribed by a darker, reddish-brown, slightly elevated line; tufts of fertile hyphae small, rather dense, arranged in small groups; hyphae light chestnut-brown, slightly flexuous, irregular toward the apex, mostly non-septate, 100–130 × 2–3.5 μ diam.; conidia clavate-fusiform, light-brown, uniseptate, very slightly constricted, one cell slightly larger than the other, 20–30 × 4–5 μ.

On living leaves of *Robinia pseudacacia*, Glen Sligo near Takoma Park, D. C. Type material, no. 935, Mr. & Mrs. C. L. S., May 3, 1899, deposited in herbarium U. S. Dept. of Agriculture, and to be distributed in Fungi Columbiana, Century XVII.

The affected leaves soon turn yellow and fall. The fungus proved quite destructive to the foliage on several trees in the locality mentioned.

Illosporium conicolum E. & E. sp. nov.

Sporodochia yellowish-rose color, minute, 75–80 μ diameter, globose and sessile by a short, stipe-like base; conidia globose-conic, hyaline, 6–8 μ diam., forming a continuous superficial layer borne on obscure, short, thick, conglutinated hyphae hardly distinguishable from the conidia.

Issued in Ellis & Everhart, Fungi Columbiana, no. 1497. On scales of pine cones (*Pinus Virginiana*), Takoma Park, D. C., December, 1899, and March, 1902. C. L. Shear. The above description is supplied by Mr. Ellis.

Allied to *Illosporium coccinellum* Cooke.

Phragmidium Andersoni sp. nov.

I. and II. not seen. III. Sori amphigenous, slightly pulvinate, yellowish, scattered, sparse or abundant, 200–400 μ diameter; teleutospores oblong-cylindric, densely tuberculate-roughened, nearly black and opaque when mature, 60–75 × 32–34 μ, 2–4-septate; septa convex; apex with a small, blunt, nearly hyaline papilla which is occasionally obscure; pedicel colorless, 60–105 μ long, the lower half with an oblong or elliptical rugulose roughened fistulose enlargement 15–20 μ diameter.

Type material no. 319 Griffiths, West American Fungi on *Potentilla fruticosa*, Big Horn Mts., Wyoming, Williams & Griffiths, August, 1898. Other specimens examined: No. 137 Anderson, Parasitic Fungi Mont. Upper Sand Coulee, Mont., August, 1888, on *Potentilla fruticosa* Myc. Herb. Dept. of Agriculture and no. 319a Griffiths, West Amer. Fungi. Collected on same host by C. L. S. & E. A. Bessey, no. 988, near Grand Lake, Colo.; also no. 1201 Merrill & Wilcox, Jackson, Wyo., 1901. This was first collected, so far as I know, by my late lamented friend, F. W. Anderson, whose name I have associated with it. It appears quite different from any of the species heretofore described on *Potentilla* but seems related to *P. rubi*, especially in the character of the pedicel.

Aecidium atriplicis sp. nov.

Spermagonia not seen.

Pseudoperidia hypophyllous, thickly and mostly evenly scattered over the surface, .5–1 mm. long, 240–320 μ diameter, closely surrounded at the base by the ruptured epidermis; margin coarsely crenate-dentate; cells mostly irregularly pentagonal, 20–30 μ diameter, densely reticulate-ridged, appearing densely and minutely papillate with low magnification; spores smooth, yellowish, irregularly globose, 20–24 μ diameter.

On leaves of *Atriplex Nuttallii*, Montrose, Colo. Type no. 975, C. L. S., July, 1897. Type material, Griffiths, West American Fungi, no 321. The fungus attacks almost or quite every leaf of the plants affected, making them dwarfed and stunted so that they produce little or no inflorescence. The leaves are about normal in appearance on the upper surface, but slightly thickened and below the normal in size.

Aecidium zephyranthis sp. nov.

Spermagonia sordid yellowish, occupying circular yellowish spots 1–2 mm. in diameter; spermatia globose or subglobose, 2–3 μ diameter.

Pseudoperidia amphigenous, crowded in 1–4 irregular circular series about the spermagonial spots, short with white torn edges, 200–300 μ diameter, cells irregularly quadrangular or pentagonal, 21–35 μ diameter, closely reticulated, appearing densely and minutely papillate under ordinary magnification; spores yellowish, smooth, irregularly globose, 18–25 μ diameter.

On leaves of *Zephyranthes* sp. near Tlalpam, Valley of Mexico, Mexico, Dr. J. N. Rose, no. 5478, July 15, 1901. With a $\frac{1}{6}$- or $\frac{1}{8}$- in. objective the cells of the pseudoperidia appear papillate but with a $\frac{1}{12}$- oil immersion the surface is seen to be densely reticulate-ridged.

Diatrypella rimosa sp. nov.

Stromata scattered or somewhat gregarious, erumpent, mostly elliptical, sometimes suborbicular, white within, 1–3 mm. long mostly 2 mm., slightly constricted at the base, closely surrounded by the ruptured epidermis and a black circumscribing line which reaches to the wood leaving a whitish scar when the bark is removed; disk plane or slightly convex, nearly smooth except for the slightly prominent indistinctly 4-sulcate ostiola, transversely rimose; perithecia 5–15, monostichous, ovate or angular by mutual pressure; asci elongate-clavate, long-stipitate, paraphysate, 90–135 × 6–7 μ (p. sp. 60–70 × 6–7); paraphyses numerous, slender, multiguttulate, longer than the asci; sporidia numerous, yellowish-brown in mass, slightly curved, 5–7 × 1.5 μ.

Type material on *Alnus* sp., Wallowa Lake, Oregon, no. 980, C. L. S., 1899, distributed in Griffiths, West American Fungi, no. 320. Apparently most nearly related to *D. discoidea alni* Cooke. but differs in having the surface of the disk almost pure black, the ostiola less conspicuous and not so distinctly stellate, and also in its rimose character.

From *D. tocciacana* it differs in the form and color of the stroma, the stroma being contracted at the base instead of enlarged. From *D. verrucaeformis* it differs in its more regular, smoother, darker and rimose stroma and less conspicuous and less regular ostiola as well as in the measurements of the asci.

Pleomassaria magnoliae sp. nov.

Perithecia gregarious, seated on the inner bark and permanently covered by the slightly pustulate epidermis, depressed spherical or sublenticular, thick-walled, coriaceo-carbonaceous, 600–800 μ diam., with a small conical ostiolum which just pierces the epidermis; asci clavate, very short-stipitate, 8-spored, 195–230 × 55–60 μ; paraphyses filiform; sporidia inordinate, mostly massed near the apex of the ascus, oblong-ovate, constricted below the middle, at first hyaline and 3–6-septate, then olivaceous and muriform-septate, finally deep brown, enclosed in a hyaline envelope, 66–78 × 21–23 μ exclusive of envelope.

On dead *Magnolia obovata*, cultivated on grounds of the Dept. of Agriculture from China and Japan, March 12, 1902. Type material, C. L. S. no. 1035 and Fungi Col. Century XVII.

Associated with *Camarosporium magnoliae* Shear of which it may be the mature form.

Camarosporium magnoliae sp. nov.

Perithecia same as in *Pleomassaria magnoliae* but slightly smaller; sporules subglobose to clavate, at first hyaline, becoming deep olive-brown and densely muriform-septate at maturity, subsessile, body elliptic with a short basal prolongation which is 2–3-septate, 100–112 × 28 μ; paraphyses rather stout, septate, 45–70 × 7–8 μ.

On dead *Magnolia obovata* associated with *Pleomassaria magnoliae*, U. S. Dept. of Agriculture Grounds, Washington, D. C., March 12, 1902, C. L. S., no. 1034.

Members of this genus have been regarded as pycnidial forms of *Pleomassaria* but this has not been demonstrated by cultures so far as I know. The perithecia of the two forms described above are so nearly identical that it seems probable that the asci are developed in the same perithecia as the sporules.

Haplosporella rhizophila sp. nov.

Stromata .5–1.5 mm. in diam., gregarious or crowded, erumpent, pulvinate-verrucose, deep brownish-black, carbonaceous, somewhat pulverulent, rather regular in outline and somewhat contracted at the base which is closely surrounded by the bark; cells of the stroma 2–10, monostichous, very irregular in size and shape, partitions membranous, composed of light olivaceous hyphae; ostiola inconspicuous, plane or slightly prominten; sporules oblong-elliptic, frequently inequilateral, deep olivaceous, brown, 15–21 × 6–8 μ, usually uniguttate; sporophores less than

the length of the sporules; paraphyses abundant in mature plants, very variable in length but much exceeding the spore, 2–2.5 μ in diameter.

Type on dead, exposed roots of *Ulmus* sp., Lincoln, Neb., no. 981. C. L. Shear, March 30, 1895. Type material deposited in the Myc. Herb. U. S. Dept. of Agriculture.

In a poorly developed condition the stroma is very small and almost simple, suggesting *Sphaeropsis* but examination shows that this is an abnormal, aborted state. The cells of the stroma do not all appear to be entirely distinct but some seem to connect with each other. The spores of this are almost identical with those of *Sphaeropsis ulmea* Ell. & Barth. with type material of which I have been able to compare it through the kindness of Mr. Bartholomew. There is no resemblance between the two plants in other respects however.

PESTALOZZIA GUEPINI **vaccinii** subsp. nov.

Sporules elliptic to oblong-elliptic, somewhat inequilateral. usually 4-septate, 21–24 × 8–9 μ. the three central cells dark colored, usually guttulate with the septum below the upper one darker colored than the others; apical setae 3–4, 22–35 μ long; basal seta 6–12 μ. The fungus forms no spots on the leaves but develops evenly over the surface of the yellow fallen leaves, apparently preferring the lower surface.

Type no. 1146, on dead leaves of *Vaccinium macrocarpon* kept in a moist chamber in the laboratory for about a week. Plants from which the leaves were taken were collected at Parkdale, N. J., by the writer.

This plant has apparently been referred heretofore to *P. guepini*, Desm. Ann. Sci. Nat. Bot. 2d Ser. **3**: 182. *t. 4. f. 1–3.* 1848. It agrees fairly well in many respects with the description and figures of that species but differs decidedly from the specimens issued in the exsiccatae at hand. Hosts are given by Desmazierès (*l. c.*) as follows: "Habitat in foliis siccis Camelliae et Magnoliae" and his Pl. Crypt. fasc. XXII. is cited as containing a specimen. Specimens on *Camellia Japonica* from three different collections (no. 150 Briosi & Cavara, Fun. Par. Pia. Col. no. 974; Saccardo Myc. Ven. and an unnumbered specimen from G. W. Clinton, Buffalo, N. Y.) agree well with each other and are well represented by the figure accompanying Briosi & Cavara's specimens.

The spores are however quite different from those figured by Desmazierès. The leaf figured by him appears to be that of *Camellia* rather than *Magnolia*, but the spores may possibly have been figured from the specimen on *Magnolia* to which he refers in his description.

No. 553 Rav. Fun. Amer. on persimmon (*Diospyros*) and 526 E. & E. N. A. F. on *Camellia Japonica* were distributed under this name but the material in the Department herbarium is old and poor, showing no spores.

Whichever may prove to be the type of Desmazierès' species, we believe the plant we have is sufficiently characteristic to deserve recognition as a variety at least. The fungus appears abundantly on apparently healthy leaves after they have been dampened and kept in a moist chamber for a week or ten days.

Plectrothrix gen. nov.

Sterile hyphae creeping, scanty; fertile, erect scattered with more or less irregularly arranged spinose branches near the apex; conidia globose, hyaline, borne singly on the tips of the branches.

This appears most nearly related to the genus *Monosporium* Bon., as treated by Saccardo, but differs in the much simpler fertile hyphae with the peculiar spur-like branches, to which the name refers. The type of the genus is

Plectrothrix globosa sp. nov.

Evenly effused or slightly tufted; sterile hyphae, scanty, hyaline or subhyaline or subhyaline, septate; fertile hyphae, erect, evenly scattered over the matrix or sometimes in small groups, 3–5-septate, hyaline or slightly colored toward the base, 250–350 × 3–4 μ, apex acute with 3–9 short, conical or spur-like branches, which are usually not longer than the diameter of the spores; the lower sometimes prolonged and dichotomous at the tip; conidia globose, hyaline, 15–20 μ diam., contents homogeneous.

On leaves of *Vaccinum macrocarpon* kept in a moist chamber in the laboratory, Dept. of Agriculture, Washington, D. C. Type material no. 1108, C. L. S. in Myc. Herb. U. S. Dept. Agriculture. This fungus followed regularly the appearance and maturity of *Pestalozzia guepini vaccinii* on cranberry leaves kept in a moist chamber from one to two weeks.

BUREAU OF PLANT INDUSTRY, U. S. DEPT.
AGRICULTURE, WASHINGTON, D. C.

Studies in North American Discomycetes. II. Some new or noteworthy Species from central and western New York

By Elias J. Durand

My studies in the Discomycetes extending over several years have brought to light many interesting forms which it is my plan to discuss in this and future papers. Many of these undoubtedly represent undescribed species, while others present such interesting features of already known species that notes upon them will, it is hoped, lead toward a better understanding of our discomycete flora. I wish especially to acknowledge my indebtedness to Dr. H. Rehm, whose work upon the Discomycetes of central Europe will long remain a model for workers elsewhere; and of whose kindly assistance and critical opinions, always so freely extended, I have constantly availed myself.

Ascobolus atro-fuscus Phil. & Plow. Grevillea, **2**: 186. *pl. 24. f. 1.* 1874

A. viridis Boud. Ann. Sci. Nat. V. **10**: 217. *pl. 5. f. 4.* 1869. (Not Currey.)

A. carbonicola Boud. Bull. Soc. Bot. Fr. **24**: 310. 1877.

Phaeopezia Nuttallii E. & E. N. A. F. no. 2908. (Nomen ined.)

Exsicc.: Phil. Elv. Brit. no. 47; E. & E. N. A. F. no. 2908.

Ascomata scattered, sessile, at first spherical and closed, later expanding, becoming orbicular, flattened and scutellate, sometimes contorted, often attached to the substratum by white mycelial threads, 1–10 mm. in diameter; when fresh yellow or greenish-yellow, but in drying and at maturity the disk becomes yellowish-brown, finally dark chestnut or almost black, and papillate from the projecting asci. The exterior usually remains yellowish-brown and furfuraceous, with the margin slightly inrolled. Excipulum parenchymatous throughout, composed of irregularly rounded cells of variable size, 15–50 μ in diameter, the ectal ones projecting from the surface in groups. Hypothecium rather sharply differentiated, cells small, not more than 10 μ in diameter. Hymenium about $\frac{1}{3}$ the total thickness of the cup at the base. Asci clavate-cylindrical, apex rounded and blue with iodine, 150 × 12–15 μ; spores

8, brown, minutely verrucose, broadly elliptical, 18–25 × 9–15 μ; paraphyses numerous, longer than the asci, hyaline, septate, filiform, curved or circinate, sometimes irregularly knobbed at the apex, imbedded in a greenish-yellow jelly.

On burnt wood and soil, New York, *Durand*, nos. 984, 985, 994, 992; W. Virginia, *Nuttall*. Reported also from California, on dung, *Harkness & Moore*, and from Nebraska, on wet sandy ground, *Clements*.

This species was described from specimens collected in England, on charcoal beds. It has been found elsewhere in similar situations in France, Germany and Switzerland. In September, 1900, it was my good fortune to find numerous plants of this species growing in a burnt-out swamp, near Canandaigua, N. Y. The ascomata were in all stages of development, and were attached to burnt wood and adjacent burnt soil. The above description was drawn from fresh plants. I have compared the specimen in N. A. F. no. 2908 with that in the Elv. Brit. no. 47, in my herbarium, and find them identical.

DETONIA FULGENS (Pers.) Rehm; Rab. Krypt. Flora, 1^3: 1269. 1896

Peziza fulgens Pers. Myc. eur. **1**: 241. 1822.

Pseudoplectania fulgens Fckl. Symb. Myc. 324. 1869.

Otidella fulgens (Pers.) Sacc. Syll. Fung. **8**: 99. 1889.

Barlaea fulgens (Pers.) Rehm, Rab. Krypt.-Flora, 1^3: 930. 1894.

Plants usually solitary but occasionally clustered, nearly sessile or with a short thick stem, attached by a yellowish mass of mycelial threads to the soil which it binds together. Ascomata cup-shaped, bowl-shaped, or rarely spread out flat, usually with the margin slightly incurved, commonly regular but often contorted or split at the margin, 0.5–2.5 cm. in diameter; disk clear yellow or orange-yellow, externally yellow at first but becoming greenish, finally yellowish-olive, smooth or pruinose. Excipulum entirely parenchymatous, cells small, the cortical ones rounded, 10–20 μ in diameter, the medullary ones elongated and irregular, showing their hyphal origin. Hymenium about ¼ the total thickness of the cup below. Asci narrowly clavate-cylindrical, apex rounded, not at all blue with iodine, 125–150 × 9–10 μ; spores 8, uniseriate or subbiseriate, hyaline, smooth, globose, 5–8 μ in diameter. Paraphyses slender, filled with orange granules above.

Fine specimens of this beautiful species were collected at Ithaca during the week of May, 1901 (Herb. Cornell, no. 5807). The locality was low warm beech woods, where the plants grew on the bare soil among leaves, or in clumps of moss, or rarely on fragments of rotten wood.

Saccardo established the genus *Otidella* for this species on account of its irregular form and spherical spores. In other words it was a spherical-spored *Otidea*. An examination of fresh material shows that the irregularity of mature plants is certainly not sufficiently constant or peculiar to serve as a basis for generic distinction.

Good illustrations are given by Cooke, Mycogr. *pl. 53. f. 209;* by Gillet, Disc. franc. *pl. 38;* and by Weberbauer, Pilze Nord-Deutschl. *pl. 3. f. 1.*

Hitherto reported from this country only from Deerfield, Mass., and Yosemite Valley, Cal., *Harness & Moore.*

CIBORIA LUTEOVIRESCENS (Rob.) Sacc. Syll. Fung. **8**: 206. 1889

Peziza luteovirescens Rob. Ann. Sci. Nat. III. **8**: 188. 1847.

Peziza pallidovirescens Phil. Grevillea, **6**: 24. 1877.

Hymenoscypha luteovirescens (Rob.) Phil. Man. Brit. Disc. 121. 1887.

EXSICC.: Phill. Elv. Brit., no. 122.

Plants solitary, stipitate; ascomata plane with a slight margin, waxy-membranous, about 2 mm. broad, narrowed below to a long, slender, flexuous stem, 0.5–2 cm. long, tapering downward; whole plant greenish-sulfur-yellow when fresh. Cortex parenchymatous, cells rounded or polygonal, 12–15 μ in diameter. Medullary portion composed of slender hyphae loosely interwoven. Flesh of the cup greenish-yellow when crushed. Asci clavate-cylindrical, apex rounded, becoming deep blue with iodine, 135–145 × 9–10 μ; spores 8, obliquely uniseriate, hyaline, continuous, smooth, elliptical, occasionally slightly unsymmetrical, 12–16 × 5–6 μ; paraphyses filiform, slightly thickened above, somewhat longer than the asci.

On partly buried petioles lying on the ground among leaves under beech trees, Churchville, N. Y., October 26, 1901.

My plants agree with Phillips's specimens in every way except that the cups are smaller. This was also true of the German specimens described by Rehm. The length of the stem varies

with the depth under ground of the petiole from which it springs. If the latter is on the surface the stem may be very short.

Not previously reported from America.

Ciboria sulfurella (E. & E.) Rehm, *in litt.*

Helotium sulfurellum E. & E. Bull. Torrey Club, **10**: 98. 1883.

EXSICC.: Ellis, N. A. F., no. 1275.

Plants solitary, stipitate, ascoma at first vitelline- or sulfur-yellow, but on drying the disk becomes dark ochraceous, finally dark chestnut-brown or almost black, at first globose and closed, then expanding and becoming plane with a slight margin, waxy-membranous in texture, 1–4 mm. in diameter; exterior yellow, becoming chestnut, paler than the disk, furfuraceous and longitudinally striate; stem 1 mm. to 3 cm. long, slender and flexuous, tapering downward, darker and thinly tomentose below; cortex parenchymatous, cells about three times as long as broad, those of the sides and margin of the cup rounded, about 10 μ in diameter; medullary portion of the stem and cup of slender, loosely interwoven hyphae; tomentum of slender threads, 4 μ in diameter. Asci evenly clavate, apex slightly narrowed, rounded, becoming pale blue with iodine, 75–90 × 8–10 μ; spores 8, obliquely uniseriate or irregularly biseriate above, hyaline, smooth, continuous or possibly becoming 1–septate at maturity, elliptical, navicular, 9–15 × 4–6 μ; paraphyses filiform. Flesh of the cup chestnut-brown when crushed.

On partly buried petioles of *Fraxinus*, West Chester, Pa.; not uncommon in central and western New York, in autumn, occurring in moist woods, ravines and swamps where the host abounds. (Herb. Cornell, nos. 5635, 5716). In my experience the species is confined to ash petioles, but Clements reports it as growing on dead limbs in Nebraska.

Ciboria sulfurella is a very distinct species, resembling *C. luteovirescens* in form, size and habit, but differing in the color, in the strongly furfuraceous exterior and smaller asci. There is never any shade of green about the present species, but the ochraceous and chestnut tones are the ones most often met with. The color of the crushed flesh is quite different in the two species.

Ciboria Americana sp. nov.

Plants solitary, stipitate; ascomata cup-shaped, usually becoming plane, or with the margin reflexed and umbilicate, thin, waxy-membranous, pale cinnamon to brown, 3–10 mm. in diameter;

stem 2–10 mm. long, slender, darker below, with the exterior of the cup delicately furfuraceous. Cortex very thin, of polygonal cells, 8–10 μ in diameter, projecting in groups from the sides of the cup and upper part of the stem making the exterior furfuraceous. Toward the base of the stem the cells are prolonged into short hairs, 4 μ in diameter. Hypothecium parenchymatous, cells rounded, 6–10 μ in diameter. Medullary part of the stem and cup of slender hyphae loosely interwoven. Asci clavate, usually curved, about 75 × 9 μ, apex rounded, not blue with iodine; spores 8, biseriate, hyaline, smooth, continuous, eguttulate, elliptical or ovate-elliptical, slightly unsymmetrical, 9–12 × 4–5 μ; paraphyses filiform.

On the inside of decaying involucres of *Castanea vesca*, lying on the ground among leaves. Not uncommon in Coy Glen and Enfield Ravine, in the vicinity of Ithaca, N. Y., October, 1901. (Herb. Cornell, nos. 7942 and 7950, the latter the type.)

This species resembles *Ciboria* (or *Rutstroemia*) *echinophila* (Bull.) Sacc. in size, color, habit and habitat, but differs from it in the smaller spores (in the latter "12–22 × 4–5 μ," Phillips; "16–21 × 5 μ," Massee), which are not strongly curved, and which never, so far as observed, become septate. *C. echinophila* has been reported in America only by Schweinitz, from Bethlehem, Pa., and his specimen may possibly have belonged to the present species. It may be that *C. Americana* will prove to be the American representative of the European *C. echinophila*.

Sclerotinia smilacinae sp. nov.

Plants scattered on gregarious, long-stipitate; sclerotia small, 1–2 mm. in diameter, irregularly spherical, aggregated and sometimes coalesced into a thin crust-like mass 1–2 cm. in diameter; ascoma fleshy-leathery, closed and spherical at first, expanding to cup-shaped, finally becoming campanulate, usually with a depression in the center, sometimes contorted or irregular, .75–3 cm. in diameter, bright cinnamon-brown, externally smooth; stem 2–6 cm. long, 2–3 mm. thick, tapering downward, somewhat tomentose below. Cortex parenchymatous, cells irregular, 10–30 μ in diameter; hypothecium and medullary portion composed of slender hyphae loosely interwoven. Asci narrowly cylindrical, apex rounded, slightly blue with iodine, 120–140 × 6–8 μ; spores 8, obliquely uniseriate, hyaline, continuous, biguttulate, smooth, narrowly elliptical, 12–15 × 4–5 μ; paraphyses scarce, filiform, but little thickened above.

Attached to decaying rhizomes of *Smilacina racemosa*, buried in rich humus, Fall Creek, Ithaca, N. Y., May 13, 1901 (Herb. Cornell, no. 5945).

The plants are usually aggregated, a half-dozen springing from a single rhizome. The sclerotia are so small as to be easily overlooked, and seem ridiculously small for so large a plant.

The spores germinate readily in nutrient agar made up with a decoction of *Smilacina* rootstocks. The spores do not become septate at germination. One or two germ-tubes are produced which branch profusely but do not throw off conidia. Cultures on agar and on sterilized rootstocks produced the minute sclerotia in great numbers.

This species resembles *S. tuberosa* (Hedw.) Fckl. very closely, but differs in the sclerotia, which in the latter are large and tuberous, in the method of germination of the spores and in the host plant. The latter species is said to grow always in connection with the rhizomes of *Anemone nemorosa*.

CYATHICULA MARCHANTIAE (Sommf.) Sacc. Syll. Fung. **8**: 307. 1889

Peziza marchantiae Sommf. Sup. Fl. Lap. 295. 1826.

Ascomata solitary, turbinate, sessile or with a short, thick stem substance fleshy-waxy, thin, translucent, pallid-white usually with a pale lilac tint, 0.5–2 mm. in diameter; disk plane or saucer-shaped, the margin ornamented with ciliate teeth composed of bundles of narrow cells. Excipulum parenchymatous, cells polygonal, 15–18 μ in diameter. Asci clavate-cylindrical, not conspicuously narrowed below, apex rounded, not blue with iodine, 60–75 × 6–8 μ; spores 8, 1–2-seriate, hyaline, contiguous, smooth, ovate-elliptical, 8–10 × 4 μ, minutely 2-guttulate; paraphyses filiform, flexuous, exceeding the asci.

On living *Marchantia polymorpha*, Six-mile Creek, Ithaca, N. Y., November 3, 1901 (Herb. Cornell, no. 8513).

The ascomata usually spring from the margin of the thallus, or sometimes from the summits of the gametophores. One cannot, of course, be certain that this is Sommerfelt's species, but it corresponds fully with the brief description given in Saccardo's Sylloge. This in connection with the peculiar habitat renders it quite probable that ours is the form Sommerfelt had in mind. If this is true we have the interesting fact of the occurrence, in New

York State, of a species which has not been found before since its original discovery, in northern Europe, more than sixty years ago.

LACHNUM INQUILINUM (Karst.) Schroet. Krypt.-Fl. Schl. **3**[2] : 96. 1893

Helotium inquilinum Karst. Myc. Fenn. I. 147. 1871.

Lachnella inquilina Karst. Rev. Monog. 132. 1885.

Trichopeziza inquilina (Karst.) Sacc. Syll. Fung. **8** : 424. 1889.

Pezizella inquilina (Karst.) Rehm, Rab. Krypt.-Fl. **1**[3]: 675. 1892.

Ascomata scattered or gregarious, each with a short but distinct stipe, at first spherical and closed, later becoming plane with the margin upturned, when dry cupulate with the margin inrolled, 0.3–0.5 mm. in diameter, entirely white, but old specimens often becoming brownish, clothed externally with a thick coating of white hairs; hairs short, not more than 50 μ long, 3–4 μ thick, hyaline, rarely septate, more or less irregularly curved or flexuous, the tips uncinate, obtuse, smooth or granular; asci clavate, narrowed at the tips which are not blue with iodine, 35–45 × 5–6 μ; spores 8, biseriate, hyaline, continuous, smooth, clavate-cylindrical, 8–10 × 2 μ; paraphyses abundant, scarcely exceeding the asci, lanceolate-acute at the tips, 3 μ wide at the broadest part, hyaline, septa not seen.

On decaying stems and rootstocks of *Equisetum hyemale*, lying on the ground in wet places, Ithaca, N. Y., April, May and Nov. (Herb. Cornell, nos. 1041, 5836 and 8457); London, Canada, Aug. (Dearness, 2323 !).

This is distinguished among the white species of the genus by the character of the external hairs. These are sometimes so short as to be easily overlooked, but in well-developed specimens collected in the spring they are quite prominent. Their irregular flexuous character and curved tips are peculiar. Not before reported from America.

Dermatella hamamelidis (Peck) Durand

Patellaria hamamelidis Peck, Rep. **33** : 32. *pl. 2. f. 7–10.* 1880.

Lecanidion hamamelidis (Peck) Sacc. Syll. Fung. **8** : 800. 1889.

Dermatella hamamelidis E. & E. Proc. Phil. Acad. Sci. **45** : 149. 1893. (as n. sp.)

EXSICC.: E. & E. N. A. F., no. 2634.

Ascomata scattered or gregarious, originating beneath the epidermis but soon breaking through and becoming apparently sessile on the surface, 0.3–0.5 mm. in diameter, the whole plant dark reddish-brown, the disk plane scarcely margined; excipulum minutely parenchymatous, brown. Asci broadly clavate, narrowed below to a short stout base, apex rounded, not blue with iodine, 65–110 $\mu \times 15$–20; spores 8, irregularly biseriate, at first hyaline and continuous, finally becoming yellowish and three-septate, smooth, oblong-elliptical or oblong-fusiform, usually somewhat inequilateral, 15–21 $\times$ 4–6 μ; paraphyses filiform, longer than the asci, the tips yellowish and cohering to form an epithecium.

On a bark of dead limbs of *Hamamelis Virginiana*, New York, *Peck*, *Fairman*, *Durand* et al. (Herb. Cornell, nos. 923, 5808 and 7938); Penn., *Ellis*; W. Virginia (*Nuttall*).

Specimens may be collected almost any month in the year, but the best fruiting material is to be found in the late autumn. I have compared specimens authenticated by Dr. Peck as *Patellaria hamamelidis* Pk., with the specimen of *Dermatella hamamelidis* E. & E. in the N. A. F., no. 2634, also with material from Dr. Fairman determined by Ellis, and find that the three represent a single species. The continuous spore is multiguttulate. The first septum is near the middle. This is followed by one in each half simultaneously, or one half may be septated long before the other. A section shows clearly the erumpent habit of the ascomata.

BOTANICAL LABORATORY,
CORNELL UNIVERSITY.

New or noteworthy North American Grasses

By F. Lamson-Scribner and Elmer D. Merrill

Agrostis occidentalis sp. nov.

A rather stout, caespitose, glabrous perennial, about 12 dm. high, with numerous linear leaves, open lax panicles and awnless spikelets. Culms glabrous; sheaths shorter than the internodes; ligule about 4 mm. long, obtuse, somewhat lacerate; leaf blades plane, 2–3 dm. long, 3–4 mm. wide, scabrous on both surfaces. Panicles exserted, about 1.5 dm. long; common axis and branches scabrous, the latter fasciculate at the nodes, spreading or ascending, naked below, flower-bearing above. Spikelets pale green; empty glumes subequal, lanceolate, acuminate, strongly aculeolate-scabrous on the keel, 3.5–4 mm. long; flowering glume 2.5–3 mm. long, acute and minutely 4-toothed at the apex, bearing at the base a tuft of hairs one fourth to one half as long as the glume. Palea wanting.

Type specimen collected by C. L. Shear, no. 1644, in a moist glade, McMinnville, Yamhill county, Oregon, July 20, 1899.

This species in habit resembles *Agrostis virescens* H.B.K., but is at once distinguished by its awnless flowering glumes.

Elymus velutinus sp. nov.

A caespitose, densely pubescent, ashy-gray perennial about 8 dm. high, with numerous basal leaves, densely flowered spikes and long-awned flowering glumes. Culms minutely pubescent or puberulent throughout; nodes puberulent, sheaths shorter than the internodes, densely pubescent with short hairs; ligule about 1 mm. long, densely pubescent; leaf-blades linear-lanceolate, firm, flat or with somewhat incurved margins, 1–1.5 dm. long, 5–8 mm. wide, densely and softly pubescent with short hairs throughout. Spike about 10 cm. long, the spikelets slightly exceeding the internodes, and two at each node; empty glumes nearly equal, linear-lanceolate, long-acuminate-awned, 1.5–2 mm. wide, about 15 mm. long, including the awn, very strongly scabrous on the nerves; flowering glumes about 9 mm. long, scabrous, bearing a stout scabrous awn about 2 cm. in length. Palea about equaling the glume, scabrous, ciliate on the margins.

Type specimen collected at Deep Creek, San Bernardino Mountains, California, no. 2056, L. Abrams, July 30, 1901.

A most distinct species with apparently no closely related forms in North America. It is at once recognized by its ashy-gray color, due to the short dense pubescence, its very scabrous, relatively broad outer glumes and scabrous long-awned flowering glumes.

Elymus cinereus sp. nov.

A rather stout, tufted perennial, about 10 dm. high, densely short-pubescent throughout, giving the whole plant an ashy-gray appearance. Culms stout, nearly glabrous where protected by the sheaths, elsewhere densely short-pubescent; nodes pubescent; sheaths shorter than the internodes, densely pubescent, ligule thin, truncate, 2 mm. long, densely short-pubescent; leaf-blades firm, involute, 2–3 dm. long, about 5 mm. wide, densely short-pubescent on both surfaces. Spike about 15 cm. long, densely flowered, rachis puberulent. Spikelets usually two at each node, 3–4-flowered, empty glumes subequal, subulate, scabrous throughout, 10–15 mm. long, flowering glumes lanceolate, acuminate, scarcely awned, 9–10 mm. long, rather prominently strigose-pubescent throughout. Palea nearly equaling the glume, scabrous, ciliate on the margins.

Type specimens collected by C. A. Purpus, no. 6050, dry plains, Pahrump Valley, Nevada, May–October, 1898.

This species in aspect resembles *Elymus velutinus*, the pubescence of the two species being nearly the same but in other respects is not closely related to that species. Its most prominent distinguishing characters are its subulate empty glumes, which are never more than 0.5 mm. wide, and awnless flowering glumes. It is evidently related to *Elymus triticoides* Buckl., although that species is glabrous, or at least not at all pubescent.

ERAGROSTIS AMABILIS Wright & Arn. in Hook & Arn. Bot. Beechy's Voy. 251. 1841

This very distinct and beautiful species was found rather abundantly along moist roadsides, at two stations in Florida, Lloyd's and Live Oak, 65 miles apart, by Mr. A. H. Curtis, no. 6898, September 12, 1901. How has this grass a native of India become established in northern Florida? *Eragrostis amabilis* is known to florists as a desirable ornamental grass and is cultivated for ornamental purposes in the United States and it was suggested that its appearance in Florida might be explained from this fact, and that it was an escape from cultivation. Regarding this point Mr. Curtiss writes as follows: "I cannot believe *Eragrostis*

amabilis an escape from cultivation, for in the 'cracker' country where it was found, nothing but most common things are cultivated. At Lloyd's where it is well established along roads in low grounds, there is only a dinner house and a couple of stores. It is possible that the grass may have been grown at the so-called Experiment Station at Lake City, 22 miles east of Live Oak, but it is doubtful."

This species is apparently well established in northern Floirad and should certainly be recognized as a constituent of the flora of that region.

Festuca Elmeri sp. nov.

A weak, caespitose, pale green perennial, 6–8 dm. high, with long, linear, thin leaves and lax panicles. Culms glabrous. Sheaths slightly shorter than the internodes, strongly striate, the lower ones crowded and marcescent, the upper ones minutely scabro-pubescent between the striae; ligule a very short minutely ciliate ring; leaf-blades 2–3.5 dm. long, 2–3 mm. wide, plane, striate, nearly glabrous beneath, minutely scabrous or scabro-pubescent on the nerves above, especially the upper ones. Panicles 1–2 dm. long, pale green, the axis glabrous, the branches scabrous, ascending, naked below, flower-bearing at and above the middle, the lower ones often 1 dm. long. Spikelets 7–9 mm. long, 3- or 4-flowered; empty glumes unequal, the first about 2.5 mm. long, linear-lanceolate, acute, the second 3–4 mm. long, obtuse, both slightly ciliate on the hyaline margins above; flowering glumes about 5 mm. long, exclusive of the awn, lanceolate acuminate, prominently 5-nerved, rather strongly scabrous, cleft at the apex, forming two sharp teeth about 1 mm. long bearing between them a slender scabrous awn about 4 mm. in length. Palea very narrow, acuminate, 2-keeled, slightly exceeding the glumes.

Type specimen collected by A. D. E. Elmer at Stanford University, Santa Clara county, California, no. 2101, April, 1900, also secured by Le Roy Abrams from the same locality, no. 1646, May 14, 1901.

This species resembles *Festuca Jonesii* Vasey, in its habit of growth and in its very thin leaves, but is distinguished from that species by its very short ligule, much narrower leaves, more unequal empty glumes, and rather strongly scabrous flowering glumes.

KOELERIA BRACHYSTACHYS DC. Hort. Monsp. 120. 1813.

This European species was found at Pensacola, Florida, by S. M. Tracy, June 1, 1901, and we also have a specimen from King's Valley, California, collected by Mrs. R. M. Austin, July, 1882. By some European authors it is reduced to *Koeleria phleoides*, but although closely related to that species we believe it to be valid, being distinguished by its glabrous spikelets. In *Koeleria phleoides* the glumes are prominently pilose.

SCLEROPOA RIGIDA (Linn.) Griseb. Spicil. Fl. Rumel. **2**: 431. 1844

Poa rigida Linn. Amoen. Acad. **4**: 265. 1759.

Festuca rigida Kunth. Enum. **1**: 392. 1833.

This European species was introduced at Charleston, S. C., early in the nineteenth century, as it was considered by Elliott in his Sketch of the Botany of South Carolina and Georgia 1: 164. 1817.* It has also been found at Mobile, Alabama, on ballast, by Dr. Chas. Mohr, and at Fort Morgan, Alabama, by S. M. Tracy, no. 7212, April 27, 1901, and should, we believe, be considered as a constituent of the flora of the southern United States.

Sitanion marginatum sp. nov.

A densely caespitose, bright green glabrous perennial, 2–3 dm. high with short, usually spreading leaves, rather short spikes, and broad empty glumes. Ligule short, membranaceous; leaf-blades linear-lanceolate, the basal ones 5–9 cm. long, those of the culm shorter, glabrous beneath, scabrous on the rather prominent white, cartilaginous margins. Spikes 3–6 cm. long, exserted, rarely partly enclosed in the upper sheath. Spikelets crowded; empty glumes lanceolate, 1–1.2 mm. wide, about 5 mm. long, acuminate into a spreading awn about 1.5 cm. long; flowering glumes glabrous, about 7 mm. long, bearing an awn similar to that of the empty glumes.

Type specimen, no. 334 E. D. Merrill and E. N. Wilcox, collected on bare open slopes, Teton Mountains, above Leigh's Lake, Wyoming, July 26, 1901, altitude about 3,300 m.

A peculiar species very similar in habit to *Sitanion glabrum*, J. G. Smith, but on account of its relatively broad empty glumes must be placed in the section *Elymoides* in relation with *Sitanion*

*Cir. U. S. Dept. Agr. Div. Agros. 29: 11. 1901.

planifolium to which it is not closely related. Its distinguishing characters are its habit of growth, lanceolate empty glumes, glabrous flowering glumes, and prominent cartilaginous leaf-margins.

Trisetum Congdoni sp. nov.

A caespitose, erect, rigid perennial 2–3 dm. high, with erect or ascending rigid leaves, and exserted, ovate, densely-flowered panicles 4–5 cm. long, 1.5 cm. in diameter. Culms minutely puberulent. Ligule ovate, hyaline, 2–3 mm. long; leaf blades 4–5 cm. long, 2–3 mm. wide, glabrous beneath, scabrous above, flat or somewhat involute toward the apex. Panicles slightly purplish, common axis pubescent, the short branches densely flowered, spikelets mostly 2-flowered; empty glumes narrowly lanceolate, glabrous except on the scabrous keels, acuminate, 1-nerved, the first about 6 mm. long, the second 8 mm. long; flowering glumes 6 mm. long, very strongly scabrous throughout, lanceolate, acuminate, cleft at the apex, and terminating in two slender teeth about 1 mm. long; awn inserted somewhat above the middle, spreading, scabrous, 7–8 mm. long. Palea equaling the glume.

Type specimen collected by J. W. Congdon, Shadow Lake Trail, Mariposa county, California, 1899.

This species is readily distinguished from forms of *Trisetum subspicatum* by its rigid leaves, peculiar panicles, narrow empty glumes, very scabrous longer flowering glumes and longer awns.

New Species of Nemophila from the Pacific Coast

By Alice Eastwood

(With Plate 21)

Nemophila Brandegei sp. nov.

Stems branching, erect, sparingly retrorsely pubescent. Leaves generally 5-lobed, with rounded, entire or occasionally lobed, mucronate divisions, clothed with appressed pubescence, denser and finer on the lower surface, somewhat pustulate on the upper; petioles broad, dilated at base, ciliate on the margins especially at the base, about as long as the blade: peduncles 3–5 times as long as the leaves, erect in flower, recurved spreading later: calyx 7 mm. long, with lanceolate-subulate acute divisions extending almost to the base; auricles narrowly linear, about half as long as the divisions of the calyx: corolla 3.5 cm. across, blue with dotted lines in the throat, paler at base; tube hairy within, destitute of appendages but with a double line of fine hairs between each filament: divisions obcordate, almost twice as long as the tube: filaments as long as the tube: anthers ovate-acuminate, dark brown: style divided almost to the middle, hairy below the lobes; ovary sparingly hairy: no fruit. (*Pl. 21, f. 1.*)

This was collected near Japato, Fresno county, California, by Mr. T. S. Brandegee, March 26, 1893. This is one of the largest flowered species of *Nemophila* and in general appearance approaches *N. insignis*. The general habit of the plant, the much larger flowers, the difference in the inner part of the corolla tube all mark it as a distinct species. It is with pleasure that I name it in honor of Mr. Brandegee who has done so much for the herbarium of the California Academy of Sciences and for the Botany of the Pacific Coast.

There are two forms on the same sheet, one much more luxuriant than the other. The flowers in both are similar, though those of the larger specimen may be a little larger. This specimen is not complete, so the others have been taken as the type.

Nemophila macrocarpa sp. nov.

Stems long, decumbent, weak, branching, more than 30 cm. long, ribbed, glabrate near the base, retrorsely pubescent above; internodes generally exceeding the leaves: leaves 3–5 lobed, with

linear-subulate subfalcate mucronate divisions: petioles about as long as the blade and as broad as the divisions: flowers on long, slender peduncles, which exceed the leaves and the internodes, in bloom from the earliest axils; flowering calyx 7–9 mm. long, with triangular-subulate lobes, veiny, pubescent on the outer surface, glabrous within, ciliate on the margin: auricles linear, about half as long as the divisions, both increasing in length with age: corolla rotate-campanulate, white with dotted lines of blue-black radiating from the base, 2 cm. across, with rounded obtuse divisions a little longer than the tube; appendages as figured: stamens with filaments as long as the tube; anthers ovate-acuminate: style not divided to the middle, hairy below: capsule oblong-orbicular, 6 mm. long: seeds dark brown, with some scales on the rough, tuberculated surface; calyptra prominent. (*Pl. 21, f. 2.*)

This was collected by Will Price in Humboldt county. There are two specimens, one collected at Jarnagan, July 1, 1890, the type, the other fragmentary, from Kneeland Prairie collected, June 30, 1890.

Nemophila Johnsoni sp. nov.

Stems low, densely and closely branching from the base, almost caespitose, branching also above, sparingly hispid with downwardly appressed hairs, leafy with the internodes shorter than the leaves: leaves opposite, with the blades as long as the broad ciliate petioles, together 1–3 cm.; divisions 5–7, entire or lobed, mucronate, pubescent with appressed hairs which are more numerous on the upper surface and inclined to be pustulate at base on older leaves. Peduncles 3 or 4 times longer than the subtending leaves, sparingly hispid with spreading or reflexed hairs: calyx 4 mm. long, with the triangular-subulate lobes extending almost to the base, veiny, finely appressed pubescent on both sides, ciliate on the margin; auricles narrowly linear, almost half as long as the divisions: corolla rotate-campanulate, 1 cm. long, pale blue, with darker dots radiating in lines from the center: divisions two thirds the entire length, obcordate, hairy on the tube and with two denser lines of hairs between the filaments: filaments filiform, longer than the tube of the corolla; anthers black, sagittate, 1 mm. long: style divided to below the middle, the lower part and ovary hispid with white hairs: capsule becoming 5 mm. in diameter: immature seeds scaly, the calyptra prominent. (*Pl. 21, f. 3.*)

This was sent to me by Mr. A. J. Johnson, of Astoria, Oregon, in whose honor it is named. He reports it as growing on wet rocks at the head of tide water, on the Umquaw River, Coos county, Oregon.

Nemophila diversifolia sp. nov.

Stems decumbent, 15 cm. high, branched from the base and above, with slender, weak, angled stems, canescently hirsute with fine white spreading hairs; lowest leaves opposite, with generally five petiolulate, 2–3-parted divisions, the ultimate lobes rounded and obtuse; upper leaves lobed, generally unequal, 1–3 lobes on one side, three or none on the other, cuneate at base, tapering to a short petiole: flowers on slender peduncles which are shorter than the leaves, generally recurving in fruit: divisions of the calyx oblong-linear, acute, appressed hairy on both sides, margined by long and short cilia; auricles short, narrow: corolla open-campanulate, 3 mm. long, lobed half way with obtuse, orbicular divisions, 2.5 cm. wide; appendages at base triangular-attenuate, overlapping: filaments as long as the corolla tube: anthers linear-oblong: style divided one-third, lower part hairy: ovary globular, clothed with spreading hairs: capsule purple-spotted on lower part, flattened-globular: seeds immature. (*Pl. 21, f. 4.*)

This belongs to *Section V. in the groups of small-flowered *Nemophila*, though the lower leaves are those of Section VI. It is nearest to *N. inaequalis* Eastwood. It was collected by Mr. J. G. Congdon below Mormon Bar, Mariposa county, May 28, 1901. The type is in the Herbarium of the California Academy of Sciences.

Nemophila decumbens sp. nov.

Stems many from the base, branching dichotomously above with numerous weak branches, decumbent or supported on other plants, clothed with few fine recurved bristles; internodes about as long as the alternate leaves: leaves thin, variously lobed and divided, scarcely two alike; the lowest with petiolulate orbicular divisions: the uppermost oblanceolate, entire; the others 2–5-lobed with the lobes generally broad, mucronate at apex, all cinereous with upwardly appressed hairs: petioles of lower leaves wing-margined, shorter than the blades; upper leaves almost sessile: peduncles capillary, becoming recurved: upper ones longer than the subtending leaves, lower ones shorter: calyx with thin, veiny divisions 3.5 mm. long, 1.5 mm. wide, hispid externally, and slightly so on the inside near the apex, the bristles on the margins rather short; auricles short, acute, deeper green than the sepals: corolla rotate-campanulate, white with purple dots in lines; divisions broad, obovate, retuse, as long as the tube, thin hispid ex-

* Bull. Torrey Club, **28**: 240. 1901.

ternally; appendages at base thin, attached by the long side, the free part unequally triangular: filaments as long as the tube of the corolla inserted a little above the base; anthers oblong: ovary hispid; style divided more than half, slightly hispid at base: seeds 3–4: capsule corrugated, pitted; the calyptra flat, soon falling.

This was collected by Mrs. Katherine Curran (Mrs. Brandegee) on Mt. Diablo, 1883.

A CORRECTION

The name *Nemophila inconspicua* proposed by me (Bull. Torrey Club, **28**: 144. 1901) is preoccupied, there being an earlier *N. inconspicua* Henderson. For my species I would substitute the name **Nemophila pratensis.**

Explanation of Plate 21

FIG. 1. *Nemophila Brandegei* Eastwood. All parts of this are enlarged to twice the natural size except the leaves which are outlined from actual leaves.

FIG. 2. *Nemophila macrocarpa* Eastwood. Corolla and calyx twice the actual size; leaf the actual size; appendage at base of corolla five times the size.

FIG. 3. *Nemophila Johnsoni* Eastwood. Calyx and corolla twice the actual size; leaves the actual size.

FIG. 4. *Nemophila diversifolia* Eastwood. Calyx and corolla twice the actual size; *d*, *c*, *e*, *f*, *g*, outlines from actual leaves.

Trichomanes radicans

By Elizabeth G. Britton

Having come to the conclusion that *Poterophora Donnellii* Wolle, originally described as a fresh-water alga, is a filamentous prothallium of a species of *Trichomanes*, collected on trunks of trees in Florida by J. Donnell Smith, we have been somewhat surprised to learn that the only record for any species of this genus in Florida is a doubtful one. Chapman, in all three editions of his Southern Flora, states that *T. Petersii* had been sent to him among mosses from Pensacola, Florida, without stating the habitat or name of collector. As the first leaves of both *Vittaria lineata* and *Campyloneuron phyllitidis* might readily be mistaken for a small species of *Trichomanes*, there is some doubt as to whether this statement is correct. No specimens occur in Chapman's original herbarium now in the Columbia University collections, and at Biltmore no further information can be obtained from Chapman's later herbarium. Meanwhile I have made a curious set of discoveries, and confirmed the opinion held by most students of North American ferns that the species known in our text-books as *Trichomanes radicans* is quite distinct from the species originally described by Swartz.

Trichomanes radicans as collected by Swartz was from Jamaica, where it grew closely clinging to trees in the forest, and climbed by a long tomentose rootstock; the fronds were sparse, on stipes 1–3 inches long, margined by the decurrent tissue of the leaf, which is ovate-lanceolate, sub-tripinnate, and dark green. The rachis was partially margined. Leaflets patent, alternate; pinnules alternate, pinnatifid; lobes linear, apex bipartite and obtuse. Urceolate fructification subpedicellate, scarcely exserted, the lobes laciniate, membranous, cylindric. Columella long setaceous.

Compared with *T. scandens* L., he says it differs in the place where it was found, the angular rachis, which is not black; the laciniate ends of the lobes not bifid, and the shorter columella.

This comparison raises the question as to what *T. scandens* L. is, and here too we find a diversity of opinion, most authors having

followed the English school in taking as the type the specimen in the Linnaean herbarium; whereas the Germans have gone to the original plates cited by Linnaeus, of pre-Linnaean authors, and taken that as the type.

The Linnaean description is as follows:

8. TRICHOMANES *scandens* frondibus supradecompositis; foliolis alternis, pinnis alternis oblongis serratis.

"Adiantum scandens ramosissimum, laciniss retusis dissectum." Plum. fil., 76 t., 93. 1705.

"Darea ramosissima scandens." Pet. fil., 102, t. 12, fig. 5. 1712. Habitat in America.

If the type is Plumier's figure on plate 93, of his Tractatus Filicibus Americanus, 1705, it must be noted that this is a folio volume and the rhizome and part of one frond only is figured, yet it more than filled the plate with the upper part omitted, and the stipe of one frond is over a foot long, so that the fronds must have been two and a half feet long, with pinnae six to eight inches long, pinnate-pinnatifid, with linear lobes. In his description he says the rhizome is very long and stout, and that it is completely covered with dark fibers which cling closely to the bark of trees, like the ivy. The whole plant is remarkable for its great spread, being very long and branching, and giving rise to a great number of leaves, alternating on the stem, which, though delicate, are nevertheless stout; the stipes are naked, black and shining like ebony, and about as long as the leaf; the pinnae are alternate, about half a foot long, with alternate pinnules, which are about one inch long and are deeply cut into narrow, linear lobes, bearing the cup-shaped sporangia, with a membranous lid and the black bristle about a line long.

The type locality is south of Leogano, Santo Domingo, in dense forests climbing on trunks of trees.

The second Linnaean reference to Petiver's Pteridographia is simply a copy of a portion of Plumier's plate with the descriptive phrase cited by Linnaeus.

Hooker and Baker, in the Synopsis Filicum state that "Van den Bosch refers *T. scandens* L. to *T. Kunzeanum* Hook., "but that *T. scandens* of the Linnaean herbarium is described by them on another page." They recognize *T. Kunzeanum* as a variety of

T. radicans. We feel that the plant of the Linnaean herbarium should be restudied, as well as the type of *T. radicans*, which must be at Stockholm. This would probably necessitate the study of all the species which have been reduced to synonyms of one or the other, such as *T. macroclados* Kunze, *T. Lindeni* Presl, *T. Mexicanum* V. d. B., etc. For it is quite certain that the specimens in our collection which have come from various sources, include a great jumble of species from the West Indies, Central and South America and the United States. Hooker and Baker say that *T. radicans* is a "very widely diffused and variable plant,"—and from the list of localities cited by them we do not doubt this would be true of their specimens so-called.

It is quite certain, however, that our species from the Southern States is quite distinct, in spite of the fact that Eaton in his Ferns of North America says "the name proposed by Sturm, and published with a long description by Van den Bosch, is wholly superfluous." We feel that he is mistaken, and that it must be known as *Trichomanes Boschianum* Sturm. (Van den Bosch. Syn. Hymen. 160. 1868.)

This was recognized by Salomon in his nomenclator of the vascular cryptogams in 1883, but such has been the conservatism of North American botanists, that since Dr. Gray in 1852 referred the species discovered by Peters to *T. radicans*, it has gone by this name in spite of the fact that it is totally unlike any other specimens so-called.

Liriodendron Celakovskii Velen.

By Edward W. Berry

In 1881 Professor Velenovsky found a leaf in the Cretaceous Clays, near Kuchelbad, in Bohemia, which he subsequently described * under the above name. Following is his description: "Das Blatt im Umrisse rundlich, seicht dreilappig, der Mittellappen nicht viel länger als die seitlichen, vorne seicht ausgerandet, die seitlichen ebenfalls ausgerandet oder beinahe abgerundet. Der Primarnerv gerade, nicht zu stark, zur Spitze merklich verdunnt; in der oberen Hälfte desselben entspringen noch 2–3 Paare von starkeren Secundarnerven. Beiderseits des Mittelnerven entspringen am Grunde noch 2 Basalnerven, von denen der obere etwa in der Mitte seiner Länge noch ein langes Secundarastchen abzweigt, die feinere nervation ist unkenntlich. Der Blattstiel etwa 2 cm. lang, gerade, am Grunde stark."

This leaf is of considerable interest as it is the only specimen of Cretaceous age in Europe which has been referred to *Liriodendron*, the balance of the European species appearing in the later Tertiary (Oligocene, Miocene, and later) and greatly resembling the existing tulip-tree. A critical comparison convinces the writer that this leaf is in no wise related to *Liriodendron*, and the result seems worthy of publication inasmuch as it limits the known introduction of this genus into Europe to the Oligocene, and suggests that this introduction may have been from the northwest through Heer's *Liriodendron Procaccinii* of the Eocene (or at the very latest Oligocene) of Greenland and Iceland. This species in turn is the logical descendant from forms similar to those found in the Amboy Clays and related strata from New Jersey to Martha's Vineyard.

Velenovsky is positive enough that his identification of this leaf is correct and he compares it to those forms of *Liriodendron Meekii* from Nebraska. While the two leaves are much the same size, *Liriodendron Meekii* is oblong in its general outline while this

* Die Fl. der Boehm. Kreideform., Beiträge zur Palaeont. des Oesterreich-Ungarus und des Orient. E. v. Mojsisovics und M. Neumayr, 3 : 18 (43), *pl.* 6 (14), *f.* 2. 1884.

leaf is orbicular. *Liriodendron Meekii* is almost perfectly fiddle-shaped; the apical lobes are not convergent; the lateral sinuses are in the basal half of the leaf, and are quite decided; the lateral lobes are basal and directed nearly laterally; the secondaries are numerous, and the venation so far as known is that of *Liriodendron*. *Liriodendron Celakovskii* is, on the other hand, a typically trilobed leaf with palmate venation, although the sinuses are shallow and the lobes not particularly well marked; the sinuses are in the apical half of the leaf and are directed downward, while the venation is quite different from that of the former species, with few, and much curved secondaries.

The genus *Cissites* which was originally proposed by Heer to include leaves presumably allied to *Cissus*, has been made to include a variety of forms with more or less resemblance to *Vitis*, *Platanus*, *Sassafras*, *Liriodendron*, etc., by later authors. It is with some of these that Velenovsky's leaf shows a decided similarity.

Lesquereux, in discussing his *Cissites obtusilobus*,* notes its resemblance to *Liriodendron Celakovskii*, the venation being however strikingly different.

A *Cissites* which resembles this leaf is *Cissites salisburiaefolius*, Lx. which† species has been referred successively to *Populites* and to *Sassafras;* in fact it resembles some of the obtuse varieties of *Sassafras cretaceum* "so called" very much. It is a somewhat larger leaf than *Liriodendron Celakovskii* and more decidedly trilobed; in some of Lesquereux's specimens which lack the decurrent base the venation is very similar to that of *Liriodendron Celakovskii*.

Another species of *Cissites* which resembles this leaf is Lesquereux's *Cissites Harkerianus*. The two leaves are exactly the same size; the outline is the same, except for the slightly notched apex of *Celakovskii* and the somewhat decurrent base of *Harkerianus*. The venation is similar in the straight primaries and few greatly arched secondaries. ‡

Another species of analogous appearance is *Hedera platanoidea* Lx. His figure of this species (*pl. 3, f. 5*) resembles *Liriodendron*

* Fl. Dakota Group, 161.

† Am. Jour. Sci. 46: 94. 1868.

‡ See especially Cret. & Tert. Fl. *f. 3*.

Celakovskii considerably in both size and outline, except for the unnotched apex; the secondaries are more nearly straight, however, and there are no additional veins below the lateral primaries.

Comparing *Liriodendron Celakovskii* with the existing *Liriodendron Tulipifera* we note that, while the outline is not dissimilar from numerous *L. Tulipifera* leaves in my possession, the wide petiole enlarged at the base is widely different. The venation is decidedly different from any form of *Liriodendron*, living or extinct, which I have seen. It is most decidedly palmate, three veins which may be called primaries and two lateral secondaries branching from the summit of the petiole at the extreme base of the leaf blade. The primaries are straight and the lateral ones run directly to the tips of the obtuse lateral lobes. In *L. Tulipifera* what answers to these primaries are seldom straight, do not form such an acute angle with the midrib, and in 99 per cent. of the leaves examined do not run directly to the tips of the lobes, but branch and become more or less obliterated.

The disposition of the tertiary system in the region of the sinus is different; in *L. Tulipifera* a secondary generally runs toward the sinus, forking and striding it.

In *L. Tulipifera* the secondaries are more numerous and branch from the midrib at approximately regular intervals, nor do they ascend in sweeping curves as in *L. Celakovskii*.

The base in *L. Tulipifera* is not straight, but usually decurrent in the smaller leaves, and more or less obcordate in the larger. It would not be difficult to find additional analogues of the leaf in question, and while the writer's knowledge is far to limited to assign *Liriodendron Celakovskii* to its proper place, it would seem to be more nearly related to that somewhat heterogeneous assemblage included in *Cissites*. At least this seems to accord more nearly with its natural affinity than its reference to *Liriodendron*, and we may repeat in conclusion that it is not related to *Liriodendron*, which is the point of emphasis in the foregoing note.

PASSAIC, N. J.

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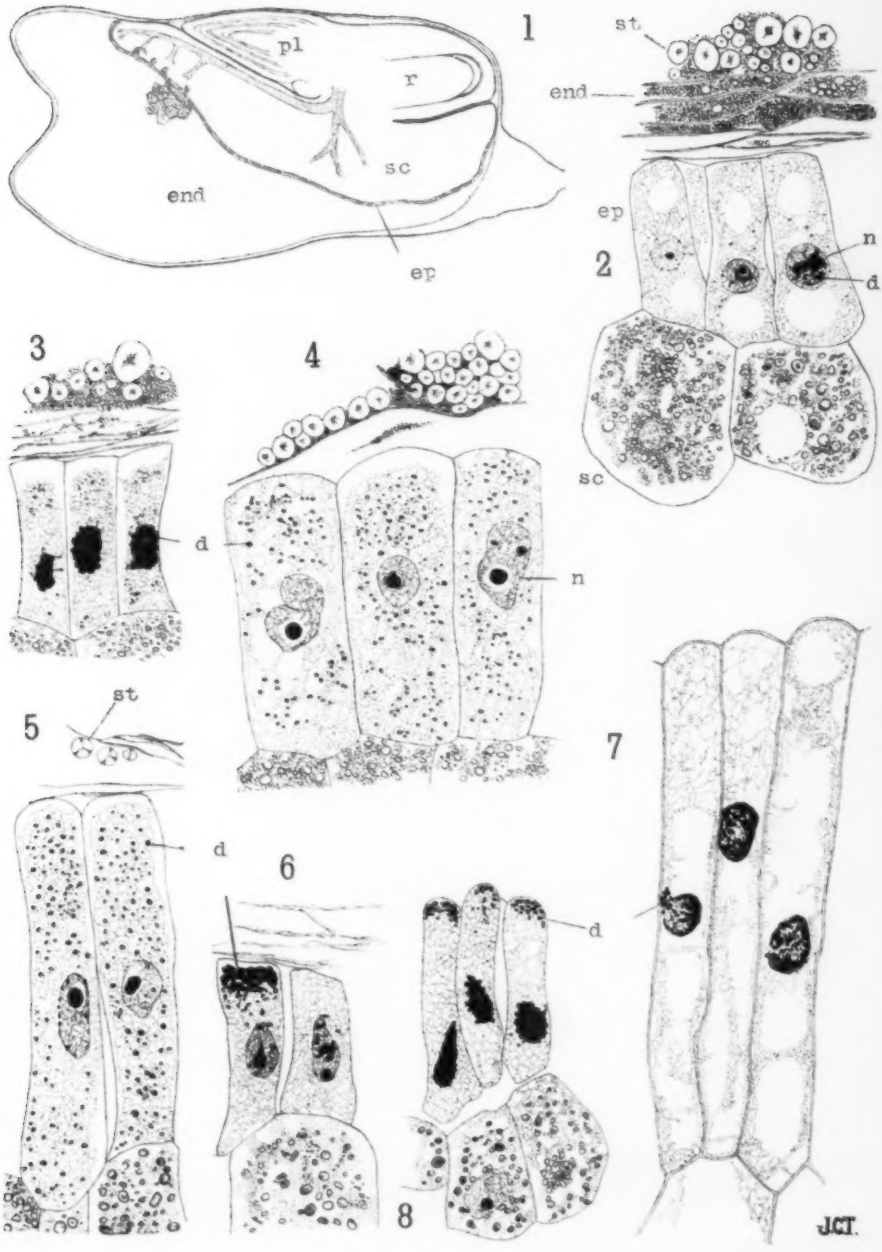
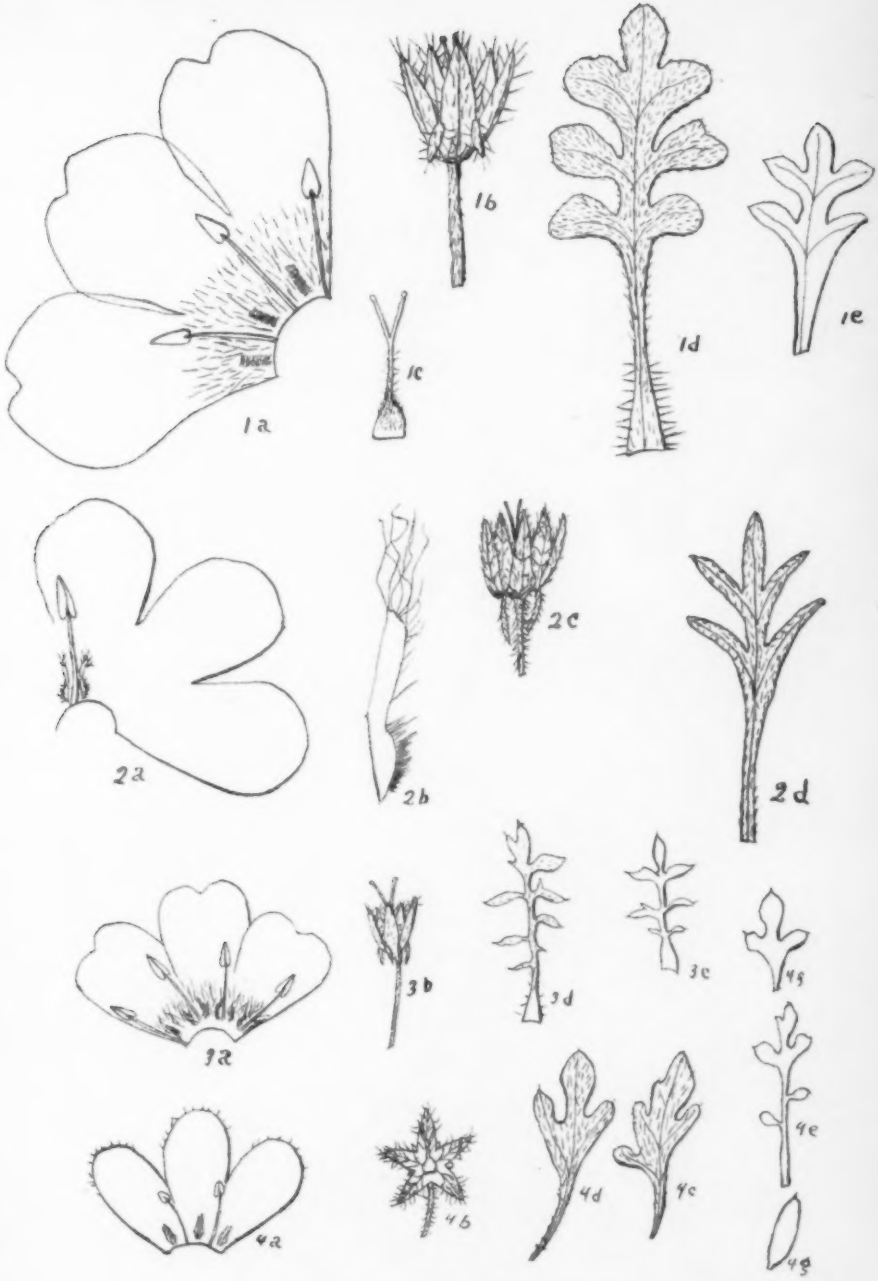


TORREY ON SECRETION EPITHELIUM.

HELIOTYPE CO., BOSTON.



1. Nemophila Brandegei. 2. N. macrocarpa. 3. N. Johnsoni. 4. N. diversifolia.

HELIOTYPE CO., BOSTON.